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(54) **POWER SUPPLY ASSEMBLY FOR  
 LED-BASED LIGHT TUBE**

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 See application file for complete search history.

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(56) **References Cited**

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U.S. PATENT DOCUMENTS

D79,814 S 11/1929 Hoch  
 D80,419 S 1/1930 Kramer

(Continued)

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FOREIGN PATENT DOCUMENTS

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CN 1584388 A 2/2005  
 CN 2766345 Y 3/2006

(Continued)

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OTHER PUBLICATIONS

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PLC-81756-AL "Fireball" Contemporary Pendant Light, [online], [retrieved on Feb. 27, 2009] Retrieved from the Arcadian Lighting Web Page using Internet <URL: <http://www.arcadianlighting.com/plc-81756-al.html>>.

(Continued)

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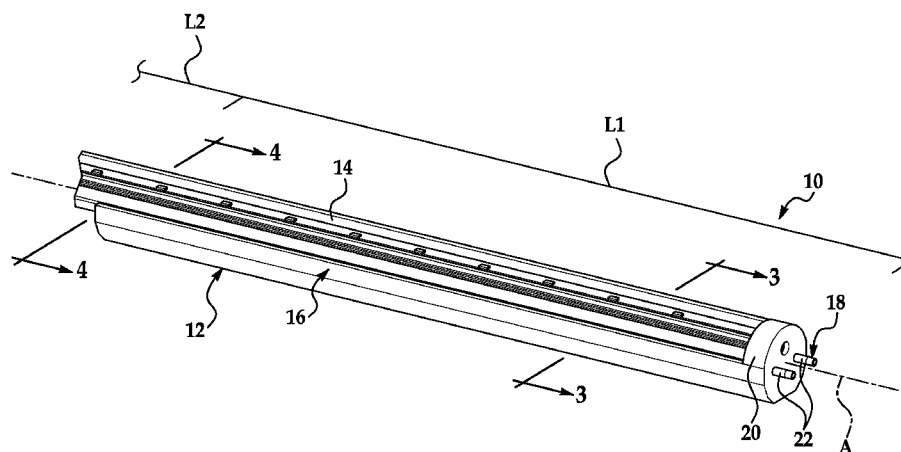
(57) **ABSTRACT**

An LED-based light for replacing a fluorescent light in a light fixture comprises: an elongate housing, the housing having a first longitudinal portion with a first cross section and a second longitudinal portion adjoining the first longitudinal portion with a second cross section, wherein a shape of the first cross section is different from a shape of the second cross section, such that the housing includes at least one geometric asymmetry; at least one LED arranged in the housing; and a connector at an end of the housing configured for connection to a light fixture.

(58) **Field of Classification Search**

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(51)	<b>Int. Cl.</b>			4,656,398 A	4/1987	Michael et al.
	<b>F21V 23/02</b>	(2006.01)		4,661,890 A	4/1987	Watanabe et al.
	<b>F21V 3/02</b>	(2006.01)		4,668,895 A	5/1987	Schneider
	<b>F21V 19/00</b>	(2006.01)		4,669,033 A	5/1987	Lee
	<b>F21Y 101/02</b>	(2006.01)		4,675,575 A	6/1987	Smith et al.
	<b>F21Y 103/00</b>	(2006.01)		4,682,079 A	7/1987	Sanders et al.
	<b>F21V 29/507</b>	(2015.01)		4,686,425 A	8/1987	Havel
	<b>F21V 29/70</b>	(2015.01)		4,687,340 A	8/1987	Havel
				4,688,154 A	8/1987	Nilssen
				4,688,869 A	8/1987	Kelly
				4,695,769 A	9/1987	Schweickardt
(56)	<b>References Cited</b>			4,698,730 A	10/1987	Sakai et al.
	<b>U.S. PATENT DOCUMENTS</b>			4,701,669 A	10/1987	Head et al.
				4,705,406 A	11/1987	Havel
				4,707,141 A	11/1987	Havel
	D84,763 S	7/1931	Stange	D293,723 S	1/1988	Buttner
	D119,797 S	4/1940	Winkler et al.	4,727,289 A	2/1988	Uchida
	D125,312 S	2/1941	Logan	4,739,454 A	4/1988	Federgreen
	2,826,679 A	3/1958	Rosenburg	4,740,882 A	4/1988	Miller
	2,909,097 A	10/1959	Alden et al.	4,748,545 A	5/1988	Schmitt
	3,272,977 A	9/1966	Holmes	4,753,148 A	6/1988	Johnson
	3,318,185 A	5/1967	Kott	4,758,173 A	7/1988	Northrop
	3,561,719 A	2/1971	Grindle	4,765,708 A	8/1988	Becker et al.
	3,586,936 A	6/1971	McLeroy	4,771,274 A	9/1988	Havel
	3,601,621 A	8/1971	Ritchie	4,780,621 A	10/1988	Bartleucci et al.
	3,612,855 A	10/1971	Juhnke	4,794,373 A	12/1988	Harrison
	3,643,088 A	2/1972	Osteen et al.	4,794,383 A	12/1988	Havel
	3,739,336 A	6/1973	Burland	4,801,928 A	1/1989	Minter
	3,746,918 A	7/1973	Drucker et al.	4,810,937 A	3/1989	Havel
	3,818,216 A	6/1974	Larraburu	4,818,072 A	4/1989	Mohebban
	3,832,503 A	8/1974	Crane	4,824,269 A	4/1989	Havel
	3,858,086 A	12/1974	Anderson et al.	4,837,565 A	6/1989	White
	3,909,670 A	9/1975	Wakamatsu et al.	4,843,627 A	6/1989	Stebbins
	3,924,120 A	12/1975	Cox, III	4,845,481 A	7/1989	Havel
	3,958,885 A	5/1976	Stockinger et al.	4,845,745 A	7/1989	Havel
	3,969,720 A	7/1976	Nishino	4,851,972 A	7/1989	Altman
	3,974,637 A	8/1976	Bergey et al.	4,854,701 A	8/1989	Noll et al.
	3,993,386 A	11/1976	Rowe	4,857,801 A	8/1989	Farrell
	4,001,571 A	1/1977	Martin	4,863,223 A	9/1989	Weissenbach et al.
	4,054,814 A	10/1977	Fegley et al.	4,870,325 A	9/1989	Kazar
	4,070,568 A	1/1978	Gala	4,874,320 A	10/1989	Freed et al.
	4,082,395 A	4/1978	Donato et al.	4,887,074 A	12/1989	Simon et al.
	4,096,349 A	6/1978	Donato	4,894,832 A	1/1990	Colak
	4,102,558 A	7/1978	Krachman	4,901,207 A	2/1990	Sato et al.
	4,107,581 A	8/1978	Abernethy	4,904,988 A	2/1990	Nesbit et al.
	4,189,663 A	2/1980	Schmutzer et al.	4,912,371 A	3/1990	Hamilton
	4,211,955 A	7/1980	Ray	4,922,154 A	5/1990	Cacoub
	4,241,295 A	12/1980	Williams, Jr.	4,929,936 A	5/1990	Friedman et al.
	4,261,029 A	4/1981	Mousset	4,934,852 A	6/1990	Havel
	4,262,255 A	4/1981	Kokei et al.	4,941,072 A	7/1990	Yasumoto et al.
	4,271,408 A	6/1981	Teshima et al.	4,943,900 A	7/1990	Gartner
	4,271,458 A	6/1981	George, Jr.	4,962,687 A	10/1990	Belliveau et al.
	4,272,689 A	6/1981	Crosby et al.	4,965,561 A	10/1990	Havel
	4,273,999 A	6/1981	Pierpoint	4,973,835 A	11/1990	Kurosu et al.
	4,298,869 A	11/1981	Okuno	4,977,351 A	12/1990	Bavaro et al.
	4,329,625 A	5/1982	Nishizawa et al.	4,979,081 A	12/1990	Leach et al.
	4,339,788 A	7/1982	White et al.	4,979,180 A	12/1990	Muncheryan
	4,342,947 A	8/1982	Bloyd	4,980,806 A	12/1990	Taylor et al.
	4,344,117 A	8/1982	Niccum	4,991,070 A	2/1991	Stob
	4,367,464 A	1/1983	Kurahashi et al.	4,992,704 A	2/1991	Stinson
	D268,134 S	3/1983	Zurcher	5,003,227 A	3/1991	Nilssen
	4,382,272 A	5/1983	Quella et al.	5,008,595 A	4/1991	Kazar
	4,388,567 A	6/1983	Yamazaki et al.	5,008,788 A	4/1991	Palinkas
	4,388,589 A	6/1983	Moldrem, Jr.	5,010,459 A	4/1991	Taylor et al.
	4,392,187 A	7/1983	Bornhorst	5,018,054 A	5/1991	Ohashi et al.
	4,394,719 A	7/1983	Moberg	5,027,037 A	6/1991	Wei
	4,420,711 A	12/1983	Takahashi et al.	5,027,262 A	6/1991	Freed
	4,455,562 A	6/1984	Dolan et al.	5,032,960 A	7/1991	Katoh
	4,500,796 A	2/1985	Quin	5,034,807 A	7/1991	Von Kohorn
	4,521,835 A	6/1985	Meggs et al.	5,036,248 A	7/1991	McEwan et al.
	4,531,114 A	7/1985	Topol et al.	5,038,255 A	8/1991	Nishihasi et al.
	4,581,687 A	4/1986	Nakanishi	5,065,226 A	11/1991	Kluitmans et al.
	4,597,033 A	6/1986	Meggs et al.	5,072,216 A	12/1991	Grange
	4,600,972 A	7/1986	MacIntyre	5,078,039 A	1/1992	Tulk et al.
	4,607,317 A	8/1986	Lin	5,083,063 A	1/1992	Brooks
	4,622,881 A	11/1986	Rand	5,088,013 A	2/1992	Revis
	4,625,152 A	11/1986	Nakai	5,089,748 A	2/1992	Ihms
	4,635,052 A	1/1987	Aoike et al.	5,103,382 A	4/1992	Kondo et al.
	4,647,217 A	3/1987	Havel	5,122,733 A	6/1992	Havel

(56)

## References Cited

## U.S. PATENT DOCUMENTS

5,126,634 A	6/1992	Johnson	5,559,681 A	9/1996	Duarte
5,128,595 A	7/1992	Hara	5,561,346 A	10/1996	Byrne
5,130,909 A	7/1992	Gross	D376,030 S	11/1996	Cohen
5,134,387 A	7/1992	Smith et al.	5,575,459 A	11/1996	Anderson
5,136,483 A	8/1992	Schoniger et al.	5,575,554 A	11/1996	Guritz
5,140,220 A	8/1992	Hasegawa	5,581,158 A	12/1996	Quazi
5,142,199 A	8/1992	Elwell	5,592,051 A	1/1997	Korkala
5,151,679 A	9/1992	Dimmick	5,592,054 A	1/1997	Nerone et al.
5,154,641 A	10/1992	McLaughlin	5,600,199 A	2/1997	Martin, Sr. et al.
5,161,879 A	11/1992	McDermott	5,607,227 A	3/1997	Yasumoto et al.
5,161,882 A	11/1992	Garrett	5,608,290 A	3/1997	Hutchisson et al.
5,164,715 A	11/1992	Kashiwabara et al.	5,614,788 A	3/1997	Mullins et al.
5,184,114 A	2/1993	Brown	5,621,282 A	4/1997	Haskell
5,194,854 A	3/1993	Havel	5,621,603 A	4/1997	Adamec et al.
5,198,756 A	3/1993	Jenkins et al.	5,621,662 A	4/1997	Humphries et al.
5,209,560 A	5/1993	Taylor et al.	5,622,423 A	4/1997	Lee
5,220,250 A	6/1993	Szuba	5,633,629 A	5/1997	Hochstein
5,225,765 A	7/1993	Callahan et al.	5,634,711 A	6/1997	Kennedy et al.
5,226,723 A	7/1993	Chen	5,640,061 A	6/1997	Bornhorst et al.
5,254,910 A	10/1993	Yang	5,640,141 A	6/1997	Myllymaki
5,256,948 A	10/1993	Boldin et al.	5,642,129 A	6/1997	Zavracky et al.
5,278,542 A	1/1994	Smith et al.	5,655,830 A	8/1997	Ruskouski
5,282,121 A	1/1994	Bornhorst et al.	5,656,935 A	8/1997	Havel
5,283,517 A	2/1994	Havel	5,661,374 A	8/1997	Cassidy et al.
5,287,352 A	2/1994	Jackson et al.	5,661,645 A	8/1997	Hochstein
5,294,865 A	3/1994	Haraden	5,673,059 A	9/1997	Zavracky et al.
5,298,871 A	3/1994	Shimohara	5,682,103 A	10/1997	Burrell
5,301,090 A	4/1994	Hed	5,684,523 A	11/1997	Satoh et al.
5,303,124 A	4/1994	Wrobel	5,688,042 A	11/1997	Madadi et al.
5,307,295 A	4/1994	Taylor et al.	5,697,695 A	12/1997	Lin et al.
5,321,593 A	6/1994	Moates	5,701,058 A	12/1997	Roth
5,323,226 A	6/1994	Schreder	5,712,650 A	1/1998	Barlow
5,329,431 A	7/1994	Taylor et al.	5,713,655 A	2/1998	Blackman
5,344,068 A	9/1994	Haessig	5,721,471 A	2/1998	Begemann et al.
5,350,977 A	9/1994	Hamamoto et al.	5,725,148 A	3/1998	Hartman
5,357,170 A	10/1994	Luchaco et al.	5,726,535 A	3/1998	Yan
5,365,411 A	11/1994	Rycroft et al.	5,731,759 A	3/1998	Finucan
5,371,618 A	12/1994	Tai et al.	5,734,590 A	3/1998	Tebbe
5,374,876 A	12/1994	Horibata et al.	5,751,118 A	5/1998	Mortimer
5,375,043 A	12/1994	Tokunaga	5,752,766 A	5/1998	Bailey et al.
D354,360 S	1/1995	Murata	5,765,940 A	6/1998	Levy et al.
5,381,074 A	1/1995	Rudzewicz et al.	5,769,527 A	6/1998	Taylor et al.
5,388,357 A	2/1995	Malita	5,784,006 A	7/1998	Hochstein
5,402,702 A	4/1995	Hata	5,785,227 A	7/1998	Akiba
5,404,094 A	4/1995	Green et al.	5,790,329 A	8/1998	Klaus et al.
5,404,282 A	4/1995	Klinke et al.	5,803,579 A	9/1998	Turnbull et al.
5,406,176 A	4/1995	Sugden	5,803,580 A	9/1998	Tseng
5,410,328 A	4/1995	Yoksza et al.	5,803,729 A	9/1998	Tsimerman
5,412,284 A	5/1995	Moore et al.	5,806,965 A	9/1998	Deese
5,412,552 A	5/1995	Fernandes	5,808,689 A	9/1998	Small
5,420,482 A	5/1995	Phares	5,810,463 A	9/1998	Kawahara et al.
5,421,059 A	6/1995	Leffers, Jr.	5,812,105 A	9/1998	Van de Ven
5,430,356 A	7/1995	Ference et al.	5,813,751 A	9/1998	Shaffer
5,432,408 A	7/1995	Matsuda et al.	5,813,753 A	9/1998	Vriens et al.
5,436,535 A	7/1995	Yang	5,821,695 A	10/1998	Vilanilam et al.
5,436,853 A	7/1995	Shimohara	5,825,051 A	10/1998	Bauer et al.
5,450,301 A	9/1995	Waltz et al.	5,828,178 A	10/1998	York et al.
5,461,188 A	10/1995	Drago et al.	5,831,522 A	11/1998	Weed et al.
5,463,280 A	10/1995	Johnson	5,836,676 A	11/1998	Ando et al.
5,463,502 A	10/1995	Savage, Jr.	5,848,837 A	12/1998	Gustafson
5,465,144 A	11/1995	Parker et al.	5,850,126 A	12/1998	Kanbar
5,473,522 A	12/1995	Kriz et al.	5,851,063 A	12/1998	Doughty et al.
5,475,300 A	12/1995	Havel	5,852,658 A	12/1998	Knight et al.
5,481,441 A	1/1996	Stevens	5,854,542 A	12/1998	Forbes
5,489,827 A	2/1996	Xia	RE36,030 E	1/1999	Nadeau
5,491,402 A	2/1996	Small	5,859,508 A	1/1999	Ge et al.
5,493,183 A	2/1996	Kimball	5,865,529 A	2/1999	Yan
5,504,395 A	4/1996	Johnson et al.	5,890,794 A	4/1999	Abtahi et al.
5,506,760 A	4/1996	Giebler et al.	5,896,010 A	4/1999	Mikolajczak et al.
5,513,082 A	4/1996	Asano	5,904,415 A	5/1999	Robertson et al.
5,519,496 A	5/1996	Borgert et al.	5,907,742 A	5/1999	Johnson et al.
5,530,322 A	6/1996	Ference et al.	5,909,378 A	6/1999	De Milleville
5,544,809 A	8/1996	Keating et al.	5,912,653 A	6/1999	Fitch
5,545,950 A	8/1996	Cho	5,917,287 A	6/1999	Haederle et al.
5,550,440 A	8/1996	Allison et al.	5,917,534 A	6/1999	Rajeswaran
			5,921,660 A	7/1999	Yu
			5,924,784 A	7/1999	Chliwnyj et al.
			5,927,845 A	7/1999	Gustafson et al.
			5,934,792 A	8/1999	Camarota

(56)

## References Cited

## U.S. PATENT DOCUMENTS

5,936,599	A	8/1999	Reymond	6,275,397	B1	8/2001	McClain
5,943,802	A	8/1999	Tijanac	6,283,612	B1	9/2001	Hunter
5,946,209	A	8/1999	Eckel et al.	6,292,901	B1	9/2001	Lys et al.
5,949,347	A	9/1999	Wu	6,293,684	B1	9/2001	Riblett
5,951,145	A	9/1999	Iwasaki et al.	6,297,724	B1	10/2001	Bryans et al.
5,952,680	A	9/1999	Strite	6,305,109	B1	10/2001	Lee
5,959,547	A	9/1999	Tubel et al.	6,305,821	B1	10/2001	Hsieh et al.
5,961,072	A	10/1999	Bodle	6,307,331	B1	10/2001	Bonasia et al.
5,962,989	A	10/1999	Baker	6,310,590	B1	10/2001	Havel
5,962,992	A	10/1999	Huang et al.	6,315,429	B1	11/2001	Grandolfo
5,963,185	A	10/1999	Havel	6,323,832	B1	11/2001	Nishizawa et al.
5,966,069	A	10/1999	Zmurk et al.	6,325,651	B1	12/2001	Nishihara et al.
5,974,553	A	10/1999	Gandar	6,334,699	B1	1/2002	Gladnick
5,980,064	A	11/1999	Metroyanis	6,340,868	B1	1/2002	Lys et al.
5,998,925	A	12/1999	Shimizu et al.	6,354,714	B1	3/2002	Rhodes
5,998,928	A	12/1999	Hipp	6,361,186	B1	3/2002	Slayden
6,000,807	A	12/1999	Moreland	6,362,578	B1	3/2002	Swanson et al.
6,007,209	A	12/1999	Pelka	6,369,525	B1	4/2002	Chang et al.
6,008,783	A	12/1999	Kitagawa et al.	6,371,637	B1	4/2002	Atchinson et al.
6,010,228	A	1/2000	Blackman et al.	6,373,733	B1	4/2002	Wu et al.
6,011,691	A	1/2000	Schreffler	6,379,022	B1	4/2002	Amerson et al.
6,016,038	A	1/2000	Mueller et al.	D457,667	S	5/2002	Piepgas et al.
6,018,237	A	1/2000	Havel	D457,669	S	5/2002	Piepgas et al.
6,019,493	A	2/2000	Kuo et al.	D457,974	S	5/2002	Piepgas et al.
6,020,825	A	2/2000	Chansky et al.	6,388,393	B1	5/2002	Illingworth
6,025,550	A	2/2000	Kato	6,394,623	B1	5/2002	Tsui
6,028,694	A	2/2000	Schmidt	6,396,216	B1	5/2002	Noone et al.
6,030,099	A	2/2000	McDermott	D458,395	S	6/2002	Piepgas et al.
6,031,343	A	2/2000	Recknagel et al.	6,400,096	B1	6/2002	Wells et al.
D422,737	S	4/2000	Orozco	6,404,131	B1	6/2002	Kawano et al.
6,056,420	A	5/2000	Wilson et al.	6,411,022	B1	6/2002	Machida
6,068,383	A	5/2000	Robertson et al.	6,411,045	B1	6/2002	Nerone
6,069,597	A	5/2000	Hansen	6,422,716	B2	7/2002	Henrici et al.
6,072,280	A	6/2000	Allen	6,428,189	B1	8/2002	Hochstein
6,084,359	A	7/2000	Hetzel et al.	6,429,604	B1	8/2002	Chang
6,086,220	A	7/2000	Lash et al.	D463,610	S	9/2002	Piepgas et al.
6,091,200	A	7/2000	Lenz	6,445,139	B1	9/2002	Marshall et al.
6,092,915	A	7/2000	Rensch	6,448,550	B1	9/2002	Nishimura
6,095,661	A	8/2000	Lebens et al.	6,448,716	B1	9/2002	Hutchison
6,097,352	A	8/2000	Zavracky et al.	6,459,919	B1	10/2002	Lys et al.
6,116,748	A	9/2000	George	6,464,373	B1	10/2002	Petrick
6,121,875	A	9/2000	Hamm et al.	6,469,457	B2	10/2002	Callahan
6,127,783	A	10/2000	Pashley et al.	6,471,388	B1	10/2002	Marsh
6,132,072	A	10/2000	Turnbull et al.	6,472,823	B2	10/2002	Yen
6,135,604	A	10/2000	Lin	6,473,002	B1	10/2002	Hutchison
6,135,620	A	10/2000	Marsh	D468,035	S	12/2002	Blanc et al.
6,139,174	A	10/2000	Butterworth	6,488,392	B1	12/2002	Lu
6,149,283	A	11/2000	Conway et al.	6,495,964	B1	12/2002	Muthu et al.
6,150,774	A	11/2000	Mueller et al.	6,511,204	B2	1/2003	Emmel et al.
6,151,529	A	11/2000	Batko	6,517,218	B2	2/2003	Hochstein
6,153,985	A	11/2000	Grossman	6,521,879	B1	2/2003	Rand et al.
6,158,882	A	12/2000	Bischoff, Jr.	6,527,411	B1	3/2003	Sayers
6,166,496	A	12/2000	Lys et al.	6,528,954	B1	3/2003	Lys et al.
6,175,201	B1	1/2001	Sid	6,528,958	B2	3/2003	Hulshof et al.
6,175,220	B1	1/2001	Billig et al.	6,538,375	B1	3/2003	Duggal et al.
6,181,126	B1	1/2001	Havel	6,540,381	B1	4/2003	Douglass, II
D437,947	S	2/2001	Huang	6,541,800	B2	4/2003	Barnett et al.
6,183,086	B1	2/2001	Neubert	6,548,967	B1	4/2003	Dowling et al.
6,183,104	B1	2/2001	Ferrara	6,568,834	B1	5/2003	Scianna
6,184,628	B1	2/2001	Ruthenberg	6,573,536	B1	6/2003	Dry
6,196,471	B1	3/2001	Ruthenberg	6,577,072	B2	6/2003	Saito et al.
6,203,180	B1	3/2001	Fleischmann	6,577,080	B2	6/2003	Lys et al.
6,211,626	B1	4/2001	Lys et al.	6,577,512	B2	6/2003	Tripathi et al.
6,215,409	B1	4/2001	Blach	6,577,794	B1	6/2003	Currie et al.
6,217,190	B1	4/2001	Altman et al.	6,578,979	B2	6/2003	Truttmann-Battig
6,219,239	B1	4/2001	Mellberg et al.	6,582,103	B1	6/2003	Popovich et al.
6,227,679	B1	5/2001	Zhang et al.	6,583,550	B2	6/2003	Iwasa et al.
6,238,075	B1	5/2001	Dealey, Jr. et al.	6,583,573	B2	6/2003	Bierman
6,241,359	B1	6/2001	Lin	D477,093	S	7/2003	Moriyama et al.
6,249,221	B1	6/2001	Reed	6,585,393	B1	7/2003	Brandes et al.
6,250,774	B1	6/2001	Begemann et al.	6,586,890	B2	7/2003	Min et al.
6,252,350	B1	6/2001	Alvarez	6,590,343	B2	7/2003	Pederson
6,252,358	B1	6/2001	Xydis et al.	6,592,238	B2	7/2003	Cleaver et al.
6,268,600	B1	7/2001	Nakamura et al.	6,596,977	B2	7/2003	Muthu et al.
6,273,338	B1	8/2001	White	6,598,996	B1	7/2003	Lodhie
				6,608,453	B2	8/2003	Morgan et al.
				6,608,614	B1	8/2003	Johnson
				6,609,804	B2	8/2003	Nolan et al.
				6,609,813	B1	8/2003	Showers et al.

(56)

**References Cited**

## U.S. PATENT DOCUMENTS

6,612,712 B2	9/2003	Nepil	6,936,968 B2	8/2005	Cross et al.
6,612,717 B2	9/2003	Yen	6,936,978 B2	8/2005	Morgan et al.
6,612,729 B1	9/2003	Hoffman	6,940,230 B2	9/2005	Myron et al.
6,621,222 B1	9/2003	Hong	6,948,829 B2	9/2005	Verdes et al.
6,623,151 B2	9/2003	Pederson	6,953,261 B1	10/2005	Jiao et al.
6,624,597 B2	9/2003	Dowling et al.	6,957,905 B1	10/2005	Pritchard et al.
D481,484 S	10/2003	Cuevas et al.	6,963,175 B2	11/2005	Archenhold et al.
6,634,770 B2	10/2003	Cao	6,964,501 B2	11/2005	Ryan
6,634,779 B2	10/2003	Reed	6,965,197 B2	11/2005	Tyan et al.
6,636,003 B2	10/2003	Rahm et al.	6,965,205 B2	11/2005	Piepgas et al.
6,639,349 B1	10/2003	Bahadur	6,967,448 B2	11/2005	Morgan et al.
6,641,284 B2	11/2003	Stopa et al.	6,969,179 B2	11/2005	Sloan et al.
6,652,117 B2	11/2003	Tsai	6,969,186 B2	11/2005	Sonderegger et al.
6,659,622 B2	12/2003	Katogi et al.	6,969,954 B2	11/2005	Lys
6,660,935 B2	12/2003	Southard et al.	6,975,079 B2	12/2005	Lys et al.
6,666,689 B1	12/2003	Savage, Jr.	6,979,097 B2	12/2005	Elam et al.
6,667,623 B2	12/2003	Bourgault et al.	6,982,518 B2	1/2006	Chou et al.
6,674,096 B2	1/2004	Sommers	6,995,681 B2	2/2006	Pederson
6,676,284 B1	1/2004	Wynne Willson	6,997,576 B1	2/2006	Lodhie et al.
6,679,621 B2	1/2004	West et al.	6,999,318 B2	2/2006	Newby
6,681,154 B2	1/2004	Nierlich et al.	7,004,603 B2	2/2006	Knight
6,682,205 B2	1/2004	Lin	D518,218 S	3/2006	Roberge et al.
6,683,419 B2	1/2004	Kriparos	7,008,079 B2	3/2006	Smith
6,700,136 B2	3/2004	Guida	7,014,336 B1	3/2006	Ducharme et al.
6,712,486 B1	3/2004	Popovich et al.	7,015,650 B2	3/2006	McGrath
6,717,376 B2	4/2004	Lys et al.	7,018,063 B2	3/2006	Michael et al.
6,717,526 B2	4/2004	Martineau et al.	7,018,074 B2	3/2006	Raby et al.
6,720,745 B2	4/2004	Lys et al.	7,021,799 B2	4/2006	Mizuyoshi
6,726,348 B2	4/2004	Gloisten	7,021,809 B2	4/2006	Iwasa et al.
6,736,525 B2	5/2004	Chin	7,024,256 B2	4/2006	Krzyzanowski et al.
6,741,324 B1	5/2004	Kim	7,029,145 B2	4/2006	Frederick
D491,678 S	6/2004	Piepgas	7,031,920 B2	4/2006	Dowling et al.
D492,042 S	6/2004	Piepgas	7,033,036 B2	4/2006	Pederson
6,744,223 B2	6/2004	Laflamme et al.	7,038,398 B1	5/2006	Lys et al.
6,748,299 B1	6/2004	Motoyama	7,038,399 B2	5/2006	Lys et al.
6,762,562 B2	7/2004	Leong	7,042,172 B2	5/2006	Dowling et al.
6,768,047 B2	7/2004	Chang et al.	7,048,423 B2	5/2006	Stepanenko et al.
6,774,584 B2	8/2004	Lys et al.	7,049,761 B2	5/2006	Timmermans et al.
6,777,891 B2	8/2004	Lys et al.	7,052,171 B1	5/2006	Lefebvre et al.
6,781,329 B2	8/2004	Mueller et al.	7,053,557 B2	5/2006	Cross et al.
6,787,999 B2	9/2004	Stimac et al.	7,064,498 B2	6/2006	Dowling et al.
6,788,000 B2	9/2004	Appelberg et al.	7,064,674 B2	6/2006	Pederson
6,788,011 B2	9/2004	Mueller et al.	7,067,992 B2	6/2006	Leong et al.
6,791,840 B2	9/2004	Chun	7,077,978 B2	7/2006	Setlur et al.
6,796,680 B1	9/2004	Showers et al.	7,080,927 B2	7/2006	Feuerborn et al.
6,799,864 B2	10/2004	Bohler et al.	7,086,747 B2	8/2006	Nielson et al.
6,801,003 B2	10/2004	Schanberger et al.	7,088,014 B2	8/2006	Nierlich et al.
6,803,732 B2	10/2004	Kraus et al.	7,088,904 B2	8/2006	Ryan, Jr.
6,806,659 B1	10/2004	Mueller et al.	7,102,902 B1	9/2006	Brown et al.
6,814,470 B2	11/2004	Rizkin et al.	7,113,541 B1	9/2006	Lys et al.
6,814,478 B2	11/2004	Menke	7,114,830 B2	10/2006	Robertson et al.
6,815,724 B2	11/2004	Dry	7,114,834 B2	10/2006	Rivas et al.
6,846,094 B2	1/2005	Luk	7,118,262 B2	10/2006	Negley
6,851,816 B2	2/2005	Wu et al.	7,119,503 B2	10/2006	Kemper
6,851,832 B2	2/2005	Tieszen	7,120,560 B2	10/2006	Williams et al.
6,853,150 B2	2/2005	Clauberg et al.	7,121,679 B2	10/2006	Fujimoto
6,853,151 B2	2/2005	Leong et al.	7,122,976 B1	10/2006	Null et al.
6,853,563 B1	2/2005	Yang et al.	7,128,442 B2	10/2006	Lee et al.
6,857,924 B2	2/2005	Fu et al.	7,128,454 B2	10/2006	Kim et al.
6,860,628 B2	3/2005	Robertson et al.	D532,532 S	11/2006	Maxik
6,866,401 B2	3/2005	Sommers et al.	7,132,635 B2	11/2006	Dowling
6,869,204 B2	3/2005	Morgan et al.	7,132,785 B2	11/2006	Ducharme
6,871,981 B2	3/2005	Alexanderson et al.	7,132,804 B2	11/2006	Lys et al.
6,874,924 B1	4/2005	Hulse et al.	7,135,824 B2	11/2006	Lys et al.
6,879,883 B1	4/2005	Motoyama	7,139,617 B1	11/2006	Morgan et al.
6,883,929 B2	4/2005	Dowling	7,144,135 B2	12/2006	Martin et al.
6,883,934 B2	4/2005	Kawakami et al.	7,153,002 B2	12/2006	Kim et al.
6,888,322 B2	5/2005	Dowling et al.	7,161,311 B2	1/2007	Mueller et al.
6,897,624 B2	5/2005	Lys et al.	7,161,313 B2	1/2007	Piepgas et al.
D506,274 S	6/2005	Moriyama et al.	7,161,556 B2	1/2007	Morgan et al.
6,909,239 B2	6/2005	Gauna	7,164,110 B2	1/2007	Pitigoi-Aron et al.
6,909,921 B1	6/2005	Bilger	7,164,235 B2	1/2007	Ito et al.
6,918,680 B2	7/2005	Seeberger	7,165,863 B1	1/2007	Thomas et al.
6,921,181 B2	7/2005	Yen	7,165,866 B2	1/2007	Li
6,926,419 B2	8/2005	An	7,167,777 B2	1/2007	Budike, Jr.
			7,168,843 B2	1/2007	Striebel
			D536,468 S	2/2007	Crosby
			7,178,941 B2	2/2007	Roberge et al.
			7,180,252 B2	2/2007	Lys et al.

(56)

## References Cited

## U.S. PATENT DOCUMENTS

D538,950	S	3/2007	Maxik	7,306,353	B2	12/2007	Popovich et al.
D538,952	S	3/2007	Maxik et al.	7,307,391	B2	12/2007	Shan
D538,962	S	3/2007	Elliott	7,308,296	B2	12/2007	Lys et al.
7,186,003	B2	3/2007	Dowling et al.	7,309,965	B2	12/2007	Dowling et al.
7,186,005	B2	3/2007	Hulse	7,318,658	B2	1/2008	Wang et al.
7,187,141	B2	3/2007	Mueller et al.	7,319,244	B2	1/2008	Liu et al.
7,190,126	B1	3/2007	Paton	7,319,246	B2	1/2008	Soules et al.
7,192,154	B2	3/2007	Becker	7,321,191	B2	1/2008	Setlur et al.
7,198,387	B1	4/2007	Gloisten et al.	7,326,964	B2	2/2008	Lim et al.
7,201,491	B2	4/2007	Bayat et al.	7,327,281	B2	2/2008	Hutchison
7,201,497	B2	4/2007	Weaver, Jr. et al.	7,329,024	B2	2/2008	Lynch et al.
7,202,613	B2	4/2007	Morgan et al.	7,329,031	B2	2/2008	Liaw et al.
7,204,615	B2	4/2007	Arik et al.	D563,589	S	3/2008	Hariri et al.
7,204,622	B2	4/2007	Dowling et al.	7,344,278	B2	3/2008	Paravantsos
7,207,696	B1	4/2007	Lin	7,345,320	B2	3/2008	Dahm
7,210,818	B2	5/2007	Luk et al.	7,348,604	B2	3/2008	Matheson
7,210,957	B2	5/2007	Mrakovich	7,350,936	B2	4/2008	Ducharme et al.
7,211,959	B1	5/2007	Chou	7,350,952	B2	4/2008	Nishigaki
7,213,934	B2	5/2007	Zarian et al.	7,352,138	B2	4/2008	Lys et al.
7,217,004	B2	5/2007	Park et al.	7,352,339	B2	4/2008	Morgan et al.
7,217,012	B2	5/2007	Southard et al.	7,353,071	B2	4/2008	Blackwell et al.
7,217,022	B2	5/2007	Ruffin	7,358,679	B2	4/2008	Lys et al.
7,218,056	B1	5/2007	Harwood	7,358,929	B2	4/2008	Mueller et al.
7,218,238	B2	5/2007	Right et al.	7,370,986	B2	5/2008	Chan
7,220,015	B2	5/2007	Dowling	7,374,327	B2	5/2008	Schexnaider
7,220,018	B2	5/2007	Crabb et al.	7,378,805	B2	5/2008	Oh et al.
7,221,104	B2	5/2007	Lys et al.	7,378,976	B1	5/2008	Paterno
7,221,110	B2	5/2007	Sears et al.	7,385,359	B2	6/2008	Dowling et al.
7,224,000	B2	5/2007	Aanegola et al.	7,391,159	B2	6/2008	Harwood
7,226,189	B2	6/2007	Lee et al.	D574,093	S	7/2008	Kitagawa et al.
7,228,052	B1	6/2007	Lin	7,396,142	B2	7/2008	Laizure, Jr. et al.
7,228,190	B2	6/2007	Dowling et al.	7,396,146	B2	7/2008	Wang
7,231,060	B2	6/2007	Dowling et al.	7,401,935	B2	7/2008	VanderSchuit
7,233,115	B2	6/2007	Lys	7,401,945	B2	7/2008	Zhang
7,233,831	B2	6/2007	Blackwell	D576,749	S	9/2008	Kitagawa et al.
7,236,366	B2	6/2007	Chen	7,423,548	B2	9/2008	Kontovich
7,237,924	B2	7/2007	Martineau et al.	7,427,840	B2	9/2008	Morgan et al.
7,237,925	B2	7/2007	Mayer et al.	7,429,117	B2	9/2008	Pohlert et al.
7,239,532	B1	7/2007	Hsu et al.	7,434,964	B1	10/2008	Zheng et al.
7,241,038	B2	7/2007	Naniwa et al.	7,438,441	B2	10/2008	Sun et al.
7,242,152	B2	7/2007	Dowling et al.	D580,089	S	11/2008	Ly et al.
7,246,926	B2	7/2007	Harwood	D581,556	S	11/2008	To et al.
7,246,931	B2	7/2007	Hsieh et al.	7,449,847	B2	11/2008	Schanberger et al.
7,248,239	B2	7/2007	Dowling et al.	D582,577	S	12/2008	Yuen
7,249,269	B1	7/2007	Motoyama	7,470,046	B2	12/2008	Kao et al.
7,249,865	B2	7/2007	Robertson	D584,428	S	1/2009	Li et al.
D548,868	S	8/2007	Roberge et al.	D584,429	S	1/2009	Pei et al.
7,252,408	B2	8/2007	Mazzochette et al.	7,476,002	B2	1/2009	Wolf et al.
7,253,566	B2	8/2007	Lys et al.	7,476,004	B2	1/2009	Chan
7,255,457	B2	8/2007	Ducharme et al.	7,478,924	B2	1/2009	Robertson
7,255,460	B2	8/2007	Lee	D586,484	S	2/2009	Liu et al.
7,256,554	B2	8/2007	Lys	D586,928	S	2/2009	Liu et al.
7,258,458	B2	8/2007	Mochiachvili et al.	7,490,957	B2	2/2009	Leong et al.
7,258,467	B2	8/2007	Saccomanno et al.	7,497,596	B2	3/2009	Ge
7,259,528	B2	8/2007	Pilz	7,498,753	B2	3/2009	McAvoy et al.
7,262,439	B2	8/2007	Setlur et al.	7,507,001	B2	3/2009	Kit
7,262,559	B2	8/2007	Tripathi et al.	7,510,299	B2	3/2009	Timmermans et al.
D550,379	S	9/2007	Hoshikawa et al.	7,510,400	B2	3/2009	Glovatsky et al.
7,264,372	B2	9/2007	Maglica	7,514,876	B2	4/2009	Roach, Jr.
7,267,467	B2	9/2007	Wu et al.	7,520,635	B2	4/2009	Wolf et al.
7,270,443	B2	9/2007	Kurtz et al.	7,521,872	B2	4/2009	Bruning
7,271,794	B1	9/2007	Cheng et al.	7,524,089	B2	4/2009	Park
7,273,300	B2	9/2007	Mrakovich	D592,766	S	5/2009	Zhu et al.
7,274,045	B2	9/2007	Chandran et al.	D593,223	S	5/2009	Komar
7,274,160	B2	9/2007	Mueller et al.	7,530,701	B2	5/2009	Chan-Wing
D553,267	S	10/2007	Yuen	7,534,002	B2	5/2009	Yamaguchi et al.
7,285,801	B2	10/2007	Eliashevich et al.	D594,999	S	6/2009	Uchida et al.
7,288,902	B1	10/2007	Melanson	7,549,769	B2	6/2009	Kim et al.
7,288,904	B2	10/2007	Numeroli et al.	7,556,396	B2	7/2009	Kuo et al.
7,296,912	B2	11/2007	Beauchamp	7,559,663	B2	7/2009	Wong et al.
7,300,184	B2	11/2007	Ichikawa et al.	7,562,998	B1	7/2009	Yen
7,300,192	B2	11/2007	Mueller et al.	D597,686	S	8/2009	Noh
D556,937	S	12/2007	Ly	7,569,981	B1	8/2009	Ciancanelli
D557,854	S	12/2007	Lewis	7,572,030	B2	8/2009	Booth et al.
7,303,300	B2	12/2007	Dowling et al.	7,575,339	B2	8/2009	Hung
				7,579,786	B2	8/2009	Soos
				7,583,035	B2	9/2009	Shteynberg et al.
				7,583,901	B2	9/2009	Nakagawa et al.
				7,594,738	B1	9/2009	Lin et al.

(56)

**References Cited**

## U.S. PATENT DOCUMENTS

D601,726 S	10/2009	Mollaert et al.	8,382,327 B2	2/2013	Timmermans et al.
7,598,681 B2	10/2009	Lys et al.	8,382,502 B2	2/2013	Cao et al.
7,598,684 B2	10/2009	Lys et al.	8,398,275 B2	3/2013	Wang et al.
7,600,907 B2	10/2009	Liu et al.	8,403,692 B2	3/2013	Cao et al.
7,602,559 B2	10/2009	Jang et al.	8,405,314 B2	3/2013	Jensen
7,618,157 B1	11/2009	Galvez et al.	8,434,914 B2	5/2013	Li et al.
7,619,366 B2	11/2009	Diederiks	8,454,193 B2	6/2013	Simon et al.
7,635,201 B2	12/2009	Deng	2001/0033488 A1	10/2001	Chliwnyj et al.
7,635,214 B2	12/2009	Perlo	2001/0045803 A1	11/2001	Cencur
7,639,517 B2	12/2009	Zhou et al.	2002/0011801 A1	1/2002	Chang
7,648,251 B2	1/2010	Whitehouse et al.	2002/0015297 A1	2/2002	Hayashi et al.
D610,724 S	2/2010	Chiang et al.	2002/0038157 A1	3/2002	Dowling et al.
7,661,839 B2	2/2010	Tsai	2002/0044066 A1	4/2002	Dowling et al.
D612,528 S	3/2010	McGrath et al.	2002/0047516 A1	4/2002	Iwasa et al.
7,690,813 B2	4/2010	Kanamori et al.	2002/0047569 A1	4/2002	Dowling et al.
7,710,047 B2	5/2010	Shteynberg et al.	2002/0047624 A1	4/2002	Stam et al.
7,710,253 B1	5/2010	Fredricks	2002/0047628 A1	4/2002	Morgan et al.
7,712,918 B2	5/2010	Siemiet et al.	2002/0048169 A1	4/2002	Dowling et al.
7,748,886 B2	7/2010	Pazula et al.	2002/0057061 A1	5/2002	Mueller et al.
7,758,207 B1	7/2010	Zhou et al.	2002/0060526 A1	5/2002	Timmermans et al.
7,759,881 B1	7/2010	Melanson	2002/0070688 A1	6/2002	Dowling et al.
D621,975 S	8/2010	Wang	2002/0074559 A1	6/2002	Dowling et al.
7,784,966 B2	8/2010	Verfuert et al.	2002/0074958 A1	6/2002	Crenshaw
7,800,511 B1	9/2010	Hutchison et al.	2002/0078221 A1	6/2002	Blackwell et al.
7,815,338 B2	10/2010	Siemiet et al.	2002/0101197 A1	8/2002	Lys et al.
7,815,341 B2	10/2010	Steadly et al.	2002/0113555 A1	8/2002	Lys et al.
7,828,471 B2	11/2010	Lin	2002/0130627 A1	9/2002	Morgan et al.
7,843,150 B2	11/2010	Wang et al.	2002/0145394 A1	10/2002	Morgan et al.
7,848,702 B2	12/2010	Ho et al.	2002/0145869 A1	10/2002	Dowling
7,850,341 B2	12/2010	Mrakovich et al.	2002/0152045 A1	10/2002	Dowling et al.
RE42,161 E	2/2011	Hochstein	2002/0152298 A1	10/2002	Kikta et al.
7,878,683 B2	2/2011	Logan et al.	2002/0153851 A1	10/2002	Morgan et al.
7,887,216 B2	2/2011	Patrick	2002/0158583 A1	10/2002	Lys et al.
7,887,226 B2	2/2011	Huang et al.	2002/0163316 A1	11/2002	Lys et al.
D634,452 S	3/2011	de Visser	2002/0171365 A1	11/2002	Morgan et al.
7,926,975 B2	4/2011	Siemiet et al.	2002/0171377 A1	11/2002	Mueller et al.
7,938,562 B2	5/2011	Ivey et al.	2002/0171378 A1	11/2002	Morgan et al.
7,946,729 B2	5/2011	Ivey et al.	2002/0176259 A1	11/2002	Ducharme
7,976,196 B2	7/2011	Ivey et al.	2002/0179816 A1	12/2002	Haines et al.
7,990,070 B2	8/2011	Nerone	2002/0195975 A1	12/2002	Schanberger et al.
7,997,770 B1	8/2011	Meurer	2003/0011538 A1	1/2003	Lys et al.
8,013,472 B2	9/2011	Adest et al.	2003/0021117 A1	1/2003	Chan
D650,097 S	12/2011	Trumble et al.	2003/0028260 A1	2/2003	Blackwell
D650,494 S	12/2011	Tsao et al.	2003/0031015 A1	2/2003	Ishibashi
D652,968 S	1/2012	Aguiar et al.	2003/0048641 A1	3/2003	Alexanderson et al.
8,093,823 B1	1/2012	Ivey et al.	2003/0052599 A1	3/2003	Sun
D654,192 S	2/2012	Maxik et al.	2003/0057884 A1	3/2003	Dowling et al.
8,118,447 B2	2/2012	Simon et al.	2003/0057886 A1	3/2003	Lys et al.
8,159,152 B1	4/2012	Salessi	2003/0057887 A1	3/2003	Dowling et al.
D660,472 S	5/2012	Aguiar et al.	2003/0057890 A1	3/2003	Lys et al.
8,167,452 B2	5/2012	Chou	2003/0076281 A1	4/2003	Morgan et al.
8,177,388 B2	5/2012	Yen	2003/0085710 A1	5/2003	Bourgault et al.
8,179,037 B2	5/2012	Chan et al.	2003/0095404 A1	5/2003	Becks et al.
8,183,989 B2	5/2012	Tsai	2003/0100837 A1	5/2003	Lys et al.
D662,236 S	6/2012	Matsushita	2003/0102810 A1	6/2003	Cross et al.
8,203,445 B2	6/2012	Recker et al.	2003/0133292 A1	7/2003	Mueller et al.
8,214,084 B2	7/2012	Ivey et al.	2003/0137258 A1	7/2003	Piepgas et al.
8,247,985 B2	8/2012	Timmermans et al.	2003/0185005 A1	10/2003	Sommers et al.
8,251,544 B2	8/2012	Ivey et al.	2003/0185014 A1	10/2003	Gloisten
8,262,249 B2	9/2012	Hsia et al.	2003/0189412 A1	10/2003	Cunningham
8,272,764 B2	9/2012	Son	2003/0218879 A1	11/2003	Tieszen
8,287,144 B2	10/2012	Pedersen et al.	2003/0222587 A1	12/2003	Dowling, Jr. et al.
8,297,788 B2	10/2012	Bishop	2003/0234342 A1	12/2003	Gaines et al.
8,299,722 B2	10/2012	Melanson	2004/0003545 A1	1/2004	Gillespie
8,304,993 B2	11/2012	Tzou et al.	2004/0007980 A1	1/2004	Shibata
8,313,213 B2	11/2012	Lin et al.	2004/0012959 A1	1/2004	Robertson et al.
8,319,407 B2	11/2012	Ke	2004/0036006 A1	2/2004	Dowling
8,319,433 B2	11/2012	Lin et al.	2004/0037088 A1	2/2004	English et al.
8,319,437 B2	11/2012	Carlin et al.	2004/0052076 A1	3/2004	Mueller et al.
8,322,878 B2	12/2012	Hsia et al.	2004/0062041 A1	4/2004	Cross et al.
8,324,817 B2	12/2012	Ivey et al.	2004/0075572 A1	4/2004	Buschmann et al.
8,337,071 B2	12/2012	Negley et al.	2004/0080960 A1	4/2004	Wu
8,376,579 B2	2/2013	Chang	2004/0090191 A1	5/2004	Mueller et al.
8,376,588 B2	2/2013	Yen	2004/0090787 A1	5/2004	Dowling et al.
8,382,322 B2	2/2013	Bishop	2004/0105261 A1	6/2004	Ducharme et al.
			2004/0105264 A1	6/2004	Spero
			2004/0113568 A1	6/2004	Dowling et al.
			2004/0114371 A1	6/2004	Lea et al.
			2004/0116039 A1	6/2004	Mueller et al.

(56)

## References Cited

## U.S. PATENT DOCUMENTS

2004/0124782	A1	7/2004	Yu	2006/0012997	A1	1/2006	Catalano et al.
2004/0130908	A1	7/2004	McClurg et al.	2006/0016960	A1	1/2006	Morgan et al.
2004/0130909	A1	7/2004	Mueller et al.	2006/0022214	A1	2/2006	Morgan et al.
2004/0141321	A1	7/2004	Dowling et al.	2006/0028155	A1	2/2006	Young
2004/0145886	A1	7/2004	Fatemi et al.	2006/0028837	A1	2/2006	Mrakovich
2004/0155609	A1	8/2004	Lys et al.	2006/0034078	A1	2/2006	Kovacik et al.
2004/0160199	A1	8/2004	Morgan et al.	2006/0050509	A9	3/2006	Dowling et al.
2004/0178751	A1	9/2004	Mueller et al.	2006/0050514	A1	3/2006	Opolka
2004/0189262	A1	9/2004	McGrath	2006/0056855	A1	3/2006	Nakagawa et al.
2004/0212320	A1	10/2004	Dowling et al.	2006/0066447	A1	3/2006	Davenport et al.
2004/0212321	A1	10/2004	Lys et al.	2006/0076908	A1	4/2006	Morgan et al.
2004/0212993	A1	10/2004	Morgan et al.	2006/0081863	A1	4/2006	Kim et al.
2004/0223328	A1	11/2004	Lee et al.	2006/0092640	A1	5/2006	Li
2004/0240890	A1	12/2004	Lys et al.	2006/0098077	A1	5/2006	Dowling
2004/0251854	A1	12/2004	Matsuda et al.	2006/0104058	A1	5/2006	Chemel et al.
2004/0257007	A1	12/2004	Lys et al.	2006/0109648	A1	5/2006	Trenchard et al.
2005/0013133	A1	1/2005	Yeh	2006/0109649	A1	5/2006	Ducharme et al.
2005/0024877	A1	2/2005	Frederick	2006/0109661	A1	5/2006	Coushaine et al.
2005/0030744	A1	2/2005	Ducharme et al.	2006/0126325	A1	6/2006	Lefebvre et al.
2005/0035728	A1	2/2005	Schanberger et al.	2006/0126338	A1	6/2006	Mighetto
2005/0036300	A1	2/2005	Dowling et al.	2006/0132061	A1	6/2006	McCormick et al.
2005/0040774	A1	2/2005	Mueller et al.	2006/0132323	A1	6/2006	Grady
2005/0041161	A1	2/2005	Dowling et al.	2006/0146531	A1	7/2006	Reo et al.
2005/0041424	A1	2/2005	Ducharme	2006/0152172	A9	7/2006	Mueller et al.
2005/0043907	A1	2/2005	Eckel et al.	2006/0158881	A1	7/2006	Dowling
2005/0044617	A1	3/2005	Mueller et al.	2006/0170376	A1	8/2006	Piepgas et al.
2005/0047132	A1	3/2005	Dowling et al.	2006/0192502	A1	8/2006	Brown et al.
2005/0047134	A1	3/2005	Mueller et al.	2006/0193131	A1	8/2006	McGrath et al.
2005/0062440	A1	3/2005	Lys et al.	2006/0197661	A1	9/2006	Tracy et al.
2005/0063194	A1	3/2005	Lys et al.	2006/0198128	A1	9/2006	Piepgas et al.
2005/0078477	A1	4/2005	Lo	2006/0208667	A1	9/2006	Lys et al.
2005/0093488	A1	5/2005	Hung et al.	2006/0215422	A1	9/2006	Laizure et al.
2005/0099824	A1	5/2005	Dowling et al.	2006/0220595	A1	10/2006	Lu
2005/0107694	A1	5/2005	Jansen et al.	2006/0221606	A1	10/2006	Dowling
2005/0110384	A1	5/2005	Peterson	2006/0221619	A1	10/2006	Nishigaki
2005/0116667	A1	6/2005	Mueller et al.	2006/0227558	A1	10/2006	Osawa et al.
2005/0128751	A1	6/2005	Roberge et al.	2006/0232974	A1	10/2006	Lee et al.
2005/0141225	A1	6/2005	Striebel	2006/0238884	A1	10/2006	Jang et al.
2005/0151489	A1	7/2005	Lys et al.	2006/0262516	A9	11/2006	Dowling et al.
2005/0151663	A1	7/2005	Tanguay	2006/0262521	A1	11/2006	Piepgas et al.
2005/0154494	A1	7/2005	Ahmed	2006/0262544	A1	11/2006	Piepgas et al.
2005/0162093	A1	7/2005	Timmermans et al.	2006/0262545	A1	11/2006	Piepgas et al.
2005/0162100	A1	7/2005	Romano et al.	2006/0265921	A1	11/2006	Korall et al.
2005/0162101	A1	7/2005	Leong et al.	2006/0273741	A1	12/2006	Stalker
2005/0174473	A1	8/2005	Morgan et al.	2006/0274529	A1	12/2006	Cao
2005/0174780	A1	8/2005	Park	2006/0285325	A1	12/2006	Ducharme et al.
2005/0184667	A1	8/2005	Sturman et al.	2007/0035255	A1	2/2007	Shuster et al.
2005/0201112	A1	9/2005	Machi et al.	2007/0035538	A1	2/2007	Garcia et al.
2005/0206529	A1	9/2005	St.-Germain	2007/0035965	A1	2/2007	Holst
2005/0213320	A1	9/2005	Kazuhiro et al.	2007/0040516	A1	2/2007	Chen
2005/0213352	A1	9/2005	Lys	2007/0041220	A1	2/2007	Lynch
2005/0213353	A1	9/2005	Lys	2007/0047227	A1	3/2007	Ducharme
2005/0218838	A1	10/2005	Lys	2007/0053182	A1	3/2007	Robertson
2005/0218870	A1	10/2005	Lys	2007/0053208	A1	3/2007	Justel et al.
2005/0219860	A1	10/2005	Schexnaider	2007/0064419	A1	3/2007	Gandhi
2005/0219872	A1	10/2005	Lys	2007/0064425	A1	3/2007	Frecska et al.
2005/0225979	A1	10/2005	Robertson et al.	2007/0070621	A1	3/2007	Rivas et al.
2005/0231133	A1	10/2005	Lys	2007/0070631	A1	3/2007	Huang et al.
2005/0236029	A1	10/2005	Dowling	2007/0081423	A1	4/2007	Chien
2005/0236998	A1	10/2005	Mueller et al.	2007/0086754	A1	4/2007	Lys et al.
2005/0242742	A1	11/2005	Cheang et al.	2007/0086912	A1	4/2007	Dowling et al.
2005/0243577	A1	11/2005	Moon	2007/0097678	A1	5/2007	Yang
2005/0248299	A1	11/2005	Chemel et al.	2007/0109763	A1	5/2007	Wolf et al.
2005/0253533	A1	11/2005	Lys et al.	2007/0115658	A1	5/2007	Mueller et al.
2005/0259424	A1	11/2005	Zampini et al.	2007/0115665	A1	5/2007	Mueller et al.
2005/0264474	A1	12/2005	Rast	2007/0120463	A1	5/2007	Hayashi et al.
2005/0265019	A1	12/2005	Sommers et al.	2007/0120594	A1	5/2007	Balakrishnan et al.
2005/0275626	A1	12/2005	Mueller et al.	2007/0127234	A1	6/2007	Jervey
2005/0276051	A1	12/2005	Caudle et al.	2007/0133202	A1	6/2007	Huang et al.
2005/0276053	A1	12/2005	Nortrup et al.	2007/0139938	A1	6/2007	Petroski et al.
2005/0276064	A1	12/2005	Wu et al.	2007/0145915	A1	6/2007	Roberge et al.
2005/0281030	A1	12/2005	Leong et al.	2007/0146126	A1	6/2007	Wang
2005/0285547	A1	12/2005	Piepgas et al.	2007/0147046	A1	6/2007	Arik et al.
2006/0002110	A1	1/2006	Dowling et al.	2007/0152797	A1	7/2007	Chemel et al.
2006/0012987	A9	1/2006	Ducharme et al.	2007/0152808	A1	7/2007	LaCasse
				2007/0153514	A1	7/2007	Dowling et al.
				2007/0159828	A1	7/2007	Wang
				2007/0165402	A1	7/2007	Weaver et al.
				2007/0165405	A1	7/2007	Chen

(56)

## References Cited

## U.S. PATENT DOCUMENTS

2007/0173978 A1	7/2007	Fein et al.	2008/0211419 A1	9/2008	Garrity
2007/0177382 A1	8/2007	Pritchard et al.	2008/0218993 A1	9/2008	Li
2007/0182387 A1	8/2007	Weirich	2008/0224629 A1	9/2008	Melanson
2007/0188114 A1	8/2007	Lys et al.	2008/0224636 A1	9/2008	Melanson
2007/0188427 A1	8/2007	Lys et al.	2008/0253125 A1	10/2008	Kang et al.
2007/0189026 A1	8/2007	Chemel et al.	2008/0258631 A1	10/2008	Wu et al.
2007/0195526 A1	8/2007	Dowling et al.	2008/0258647 A1	10/2008	Scianna
2007/0195527 A1	8/2007	Russell	2008/0278092 A1	11/2008	Lys et al.
2007/0195532 A1	8/2007	Reisenauer et al.	2008/0285257 A1	11/2008	King
2007/0200725 A1	8/2007	Fredericks et al.	2008/0285266 A1	11/2008	Thomas
2007/0205712 A1	9/2007	Radkov et al.	2008/0290814 A1	11/2008	Leong et al.
2007/0206375 A1	9/2007	Piepgas et al.	2008/0291675 A1	11/2008	Lin et al.
2007/0211461 A1	9/2007	Harwood	2008/0298080 A1	12/2008	Wu et al.
2007/0211463 A1	9/2007	Chevalier et al.	2008/0310119 A1	12/2008	Giacoma
2007/0228999 A1	10/2007	Kit	2008/0315773 A1	12/2008	Pang
2007/0235751 A1	10/2007	Radkov et al.	2008/0315784 A1	12/2008	Tseng
2007/0236156 A1	10/2007	Lys et al.	2009/0002995 A1	1/2009	Lee et al.
2007/0236358 A1	10/2007	Street et al.	2009/0016063 A1	1/2009	Hu
2007/0237284 A1	10/2007	Lys et al.	2009/0021140 A1	1/2009	Takasu et al.
2007/0240346 A1	10/2007	Li et al.	2009/0046473 A1	2/2009	Tsai et al.
2007/0241657 A1	10/2007	Radkov et al.	2009/0052186 A1	2/2009	Xue
2007/0242466 A1	10/2007	Wu et al.	2009/0059557 A1	3/2009	Tanaka
2007/0247450 A1	10/2007	Lee	2009/0059559 A1	3/2009	Pabst et al.
2007/0247842 A1	10/2007	Zampini et al.	2009/0059603 A1	3/2009	Recker et al.
2007/0247847 A1	10/2007	Villard	2009/0067170 A1	3/2009	Bloemen et al.
2007/0247851 A1	10/2007	Villard	2009/0067182 A1	3/2009	Hsu et al.
2007/0252161 A1	11/2007	Meis et al.	2009/0085500 A1	4/2009	Zampini, II et al.
2007/0258231 A1	11/2007	Koerner et al.	2009/0086492 A1	4/2009	Meyer
2007/0258240 A1	11/2007	Ducharme et al.	2009/0091929 A1	4/2009	Faubion
2007/0263379 A1	11/2007	Dowling	2009/0091938 A1	4/2009	Jacobson et al.
2007/0274070 A1	11/2007	Wedell	2009/0101930 A1	4/2009	Li
2007/0281520 A1	12/2007	Insalaco et al.	2009/0139690 A1	6/2009	Maerz et al.
2007/0285926 A1	12/2007	Maxik	2009/0140285 A1	6/2009	Lin et al.
2007/0285933 A1	12/2007	Southard et al.	2009/0175041 A1	7/2009	Yuen et al.
2007/0290625 A1	12/2007	He et al.	2009/0185373 A1	7/2009	Grajcar
2007/0291483 A1	12/2007	Lys	2009/0195186 A1	8/2009	Guest et al.
2007/0296350 A1	12/2007	Maxik et al.	2009/0196034 A1	8/2009	Gherardini et al.
2008/0003664 A1	1/2008	Tysoe et al.	2009/0213588 A1	8/2009	Manes
2008/0007945 A1	1/2008	Kelly et al.	2009/0219713 A1	9/2009	Siemiet et al.
2008/0012502 A1	1/2008	Lys	2009/0231831 A1	9/2009	Hsiao et al.
2008/0012506 A1	1/2008	Mueller et al.	2009/0268461 A1	10/2009	Deak et al.
2008/0013316 A1	1/2008	Chiang	2009/0273924 A1	11/2009	Chiang
2008/0013324 A1	1/2008	Yu	2009/0273926 A1	11/2009	Deng
2008/0018261 A1	1/2008	Kastner	2009/0284169 A1	11/2009	Valois
2008/0024067 A1	1/2008	Ishibashi	2009/0290334 A1	11/2009	Ivey et al.
2008/0037226 A1	2/2008	Shin et al.	2009/0295776 A1	12/2009	Yu et al.
2008/0037245 A1	2/2008	Chan	2009/0303720 A1	12/2009	McGrath
2008/0037284 A1	2/2008	Rudisill	2009/0316408 A1	12/2009	Villard
2008/0049434 A1	2/2008	Marsh	2010/0008085 A1	1/2010	Ivey et al.
2008/0055894 A1	3/2008	Deng	2010/0019689 A1	1/2010	Shan
2008/0062680 A1	3/2008	Timmermans et al.	2010/0027259 A1	2/2010	Simon et al.
2008/0068838 A1	3/2008	Galke et al.	2010/0033095 A1	2/2010	Sadwick
2008/0068839 A1	3/2008	Matheson	2010/0033964 A1	2/2010	Choi et al.
2008/0074872 A1	3/2008	Panotopoulos	2010/0046222 A1	2/2010	Yang
2008/0089075 A1	4/2008	Hsu	2010/0073944 A1	3/2010	Chen
2008/0092800 A1	4/2008	Smith et al.	2010/0079085 A1	4/2010	Wendt et al.
2008/0093615 A1	4/2008	Lin et al.	2010/0096992 A1	4/2010	Yamamoto et al.
2008/0093998 A1	4/2008	Dennery et al.	2010/0096998 A1	4/2010	Beers
2008/0094819 A1	4/2008	Vaish	2010/0103664 A1	4/2010	Simon et al.
2008/0094837 A1	4/2008	Dobbins et al.	2010/0103673 A1	4/2010	Ivey et al.
2008/0129211 A1	6/2008	Lin et al.	2010/0109550 A1	5/2010	Huda et al.
2008/0130267 A1	6/2008	Dowling et al.	2010/0109558 A1	5/2010	Chew
2008/0150444 A1	6/2008	Usui et al.	2010/0141173 A1	6/2010	Negrete
2008/0151535 A1	6/2008	de Castris	2010/0148650 A1	6/2010	Wu et al.
2008/0158871 A1	7/2008	McAvoy et al.	2010/0149806 A1	6/2010	Yiu
2008/0158887 A1	7/2008	Zhu et al.	2010/0157608 A1	6/2010	Chen et al.
2008/0164826 A1	7/2008	Lys	2010/0164404 A1	7/2010	Shao et al.
2008/0164827 A1	7/2008	Lys	2010/0181178 A1	7/2010	Chang et al.
2008/0164854 A1	7/2008	Lys	2010/0207547 A1	8/2010	Kuroki et al.
2008/0175003 A1	7/2008	Tsou et al.	2010/0220469 A1	9/2010	Ivey et al.
2008/0180036 A1	7/2008	Garrity et al.	2010/0265732 A1	10/2010	Liu
2008/0186704 A1	8/2008	Chou et al.	2010/0270925 A1	10/2010	Withers
2008/0192436 A1	8/2008	Peng et al.	2010/0277069 A1	11/2010	Janik et al.
2008/0198598 A1	8/2008	Ward	2010/0289418 A1	11/2010	Langovsky
2008/0211386 A1	9/2008	Choi et al.	2010/0308733 A1	12/2010	Shao
			2010/0320922 A1	12/2010	Palazzol et al.
			2011/0006658 A1	1/2011	Chan et al.
			2011/0090682 A1	4/2011	Zheng et al.
			2011/0109454 A1	5/2011	McSheffrey, Sr. et al.

(56)	References Cited				EP	0390262	B1	12/1993
U.S. PATENT DOCUMENTS					EP	0359329	B1	3/1994
					EP	0403011	B1	4/1994
					EP	0632511		1/1995
					EP	0432848	B1	4/1995
2011/0149564	A1 *	6/2011	Hsia et al. ....	362/221	EP	0659531	A1	6/1995
2011/0156584	A1	6/2011	Kim		EP	0403001	B1	8/1995
2011/0176298	A1	7/2011	Meurer et al.		EP	0525876		5/1996
2011/0199723	A1	8/2011	Sato		EP	0889283	A1	7/1999
2011/0199769	A1	8/2011	Bretschneider et al.		EP	0458408	B1	9/1999
2011/0291588	A1	12/2011	Tagare		EP	0578302	B1	9/1999
2012/0014086	A1	1/2012	Jonsson		EP	0723701	B1	1/2000
2012/0043892	A1	2/2012	Visser et al.		EP	1142452	B1	3/2001
2012/0063140	A1	3/2012	Kong		EP	0787419	B1	5/2000
2012/0080994	A1	4/2012	Chin et al.		EP	1016062	B1	8/2002
2012/0081891	A1	4/2012	Tung et al.		EP	1195740	A3	1/2003
2012/0098439	A1	4/2012	Recker et al.		EP	1149510	B1	2/2003
2012/0106144	A1	5/2012	Chang		EP	1056993	B1	3/2003
2012/0113628	A1	5/2012	Burrow et al.		EP	0766436	B1	5/2003
2012/0127726	A1	5/2012	Yen		EP	0924281	B1	5/2003
2012/0146503	A1	6/2012	Negley et al.		EP	0826167	B1	6/2003
2012/0147597	A1	6/2012	Farmer		EP	1147686	B1	1/2004
2012/0153865	A1	6/2012	Rolfes et al.		EP	1145602	B1	3/2004
2012/0155073	A1	6/2012	McCanless et al.		EP	1422975	A1	5/2004
2012/0161666	A1	6/2012	Antony et al.		EP	0890059	B1	6/2004
2012/0194086	A1	8/2012	Liu et al.		EP	1348319	B1	6/2005
2012/0195032	A1	8/2012	Shew		EP	1037862	B1	7/2005
2012/0212951	A1	8/2012	Lai et al.		EP	1346609	B1	8/2005
2012/0212953	A1	8/2012	Bloom et al.		EP	1321012	B1	12/2005
2012/0230044	A1	9/2012	Zhang et al.		EP	1610593	A2	12/2005
2012/0236533	A1	9/2012	Nakamura et al.		EP	1624728	A1	2/2006
2012/0236554	A1	9/2012	Rust		EP	1415517	B1	5/2006
2012/0243216	A1	9/2012	Lai et al.		EP	1415518	B1	5/2006
2012/0243217	A1	9/2012	Szprengiel et al.		EP	1438877	B1	5/2006
2012/0274214	A1	11/2012	Radermacher et al.		EP	1166604	B1	6/2006
2012/0275154	A1	11/2012	Hood et al.		EP	1479270	B1	7/2006
2012/0293991	A1	11/2012	Lin		EP	1348318	B1	8/2006
2012/0293996	A1	11/2012	Thomas et al.		EP	1399694	B1	8/2006
2012/0300409	A1 *	11/2012	Lee .....	361/721	EP	1461980	B1	10/2006
2012/0300445	A1	11/2012	Chu et al.		EP	1110120	B1	4/2007
2012/0300468	A1	11/2012	Chang et al.		EP	1440604	B1	4/2007
2012/0307524	A1	12/2012	Schapira et al.		EP	1047903	B1	6/2007
2012/0320598	A1	12/2012	Son		EP	1500307		6/2007
2013/0039051	A1	2/2013	Wu		EP	0922305	B1	8/2007
2013/0044471	A1	2/2013	Chen		EP	0922306	B1	8/2007
2013/0044476	A1	2/2013	Bretschneider et al.		EP	1194918	B1	8/2007
2013/0050997	A1	2/2013	Bretschneider et al.		EP	1833035	A1	9/2007
2013/0050998	A1	2/2013	Chu et al.		EP	1048085	B1	11/2007
2013/0057146	A1	3/2013	Chao		EP	1852648	A1	11/2007
2013/0058079	A1	3/2013	Dellian et al.		EP	1763650	B1	12/2007
2013/0063944	A1	3/2013	Lodhie et al.		EP	1776722	B1	1/2008
2013/0077297	A1	3/2013	Wu et al.		EP	1873012	A1	1/2008
2013/0094200	A1	4/2013	Dellian et al.		EP	1459599	B1	2/2008
2013/0148349	A1	6/2013	Pasqualini et al.		EP	1887836	A2	2/2008
FOREIGN PATENT DOCUMENTS					EP	1579733	B1	4/2008
					EP	1145282	B1	7/2008
					EP	1157428	B1	9/2008
					EP	1000522	B1	12/2008
CN	2869556	Y	2/2007		EP	1502483	B1	12/2008
CN	101016976	A	8/2007		EP	1576858	B1	12/2008
CN	101075605	A	11/2007		EP	1646092	B1	1/2009
CN	201129681	Y	10/2008		EP	1579736	B1	2/2009
CN	201184574	Y	1/2009		EP	1889519	B1	3/2009
CN	101737664	A1	6/2010		EP	1537354	B1	4/2009
DE	19651140	A1	6/1997		EP	1518445	B1	5/2009
DE	19624087	A1	12/1997		EP	1337784	B1	6/2009
DE	29819966	U1	3/1999		EP	2013530	B1	8/2009
DE	29817609	U1	1/2000		EP	1461982	B1	9/2009
DE	20018865	U1	2/2001		EP	2430888		3/2012
EP	0013782	B1	3/1983		EP	2469155	A1	6/2012
EP	0091172	A2	10/1983		EP	2573457	A1	3/2013
EP	0124924	B1	9/1987		EP	2554895	A1	6/2013
EP	0174699	B1	11/1988		FR	2813115		2/2002
EP	0197602	B1	11/1990		GB	2215024	A	9/1989
EP	0714556		1/1991		GB	2324901	A	11/1998
EP	0214701	B1	3/1992		GB	2447257	A	9/2008
EP	0262713	B1	6/1992		GB	2472345	A	2/2011
EP	0203668	B1	2/1993		GB	2486410	A	6/2012
EP	0272749	B1	8/1993		GB	2495647	A	4/2011
EP	0337567	B1	11/1993					

(56)

**References Cited**

## FOREIGN PATENT DOCUMENTS

JP 06-054289 2/1994  
 JP H6-54103 U 7/1994  
 JP 07-249467 9/1995  
 JP 7264036 10/1995  
 JP 08-162677 A 6/1996  
 JP 11-135274 A 5/1999  
 JP H11-162234 A 6/1999  
 JP H11-260125 A 9/1999  
 JP 2001-238272 A 8/2001  
 JP 2001-291406 A 10/2001  
 JP 2002-141555 A 5/2002  
 JP 3098271 U 2/2004  
 JP 2004-119078 A 4/2004  
 JP 2004-273234 A 9/2004  
 JP 2004-335426 11/2004  
 JP 2005-158363 A 6/2005  
 JP 2005-166617 A 6/2005  
 JP 2005-347214 A 12/2005  
 JP 2006-507641 A 3/2006  
 JP 2005-322866 A 12/2006  
 JP 2007-227342 A 9/2007  
 JP 3139714 U 2/2008  
 JP 2008-186758 A 8/2008  
 JP 2008-258124 A 10/2008  
 JP 2008-293753 A 12/2008  
 JP 3154200 9/2009  
 JP 2010-192229 A1 9/2010  
 JP 2010-205553 A 9/2010  
 KR 10-2004-0008244 A 1/2004  
 KR 10-2006-0112113 A 10/2006  
 KR 20-0430022 Y1 11/2006  
 KR 10-2006-0133784 A 12/2006  
 KR 10-2007-0063595 A 6/2007  
 KR 10-0781652 12/2007  
 KR 10-0844538 B1 7/2008  
 KR 10-0888669 B1 3/2009  
 KR 10-0927851 B1 11/2009  
 TW M337036 7/2008  
 TW M349465 U 1/2009  
 WO 99-06759 A1 2/1999  
 WO 99-10867 A1 3/1999  
 WO 99-31560 A2 6/1999  
 WO 99/45312 A1 9/1999  
 WO 99/57945 A1 11/1999  
 WO 00/01067 A2 1/2000  
 WO WO0225842 A2 3/2002  
 WO 02-61330 8/2002  
 WO WO02069306 A2 9/2002  
 WO WO02091805 A2 11/2002  
 WO WO02098182 A2 12/2002  
 WO WO02099780 A2 12/2002  
 WO WO03026358 A1 3/2003  
 WO WO03055273 A2 7/2003  
 WO WO03067934 A2 8/2003  
 WO WO03090890 A1 11/2003  
 WO WO03096761 A1 11/2003  
 WO WO2004021747 A2 3/2004  
 WO WO2004023850 A2 3/2004  
 WO WO2004032572 A2 4/2004  
 WO WO2004057924 7/2004  
 WO WO2004100624 A2 11/2004  
 WO WO2005031860 A2 4/2005  
 WO WO2005052751 A2 6/2005  
 WO WO2005060309 A2 6/2005  
 WO WO2005084339 A2 9/2005  
 WO WO2005089293 A2 9/2005  
 WO WO2005089309 A2 9/2005  
 WO WO2005103555 A1 11/2005  
 WO WO2005116519 A1 12/2005  
 WO WO2006023149 A2 3/2006  
 WO WO2006044328 A1 4/2006  
 WO WO2006046207 A1 5/2006  
 WO WO2006056120 A1 6/2006  
 WO WO2006093889 A2 9/2006  
 WO WO2006127666 A2 11/2006

WO WO2006127785 A2 11/2006  
 WO WO2006133272 A2 12/2006  
 WO WO2006137686 A1 12/2006  
 WO WO2007004679 A1 1/2007  
 WO WO2007081674 A1 7/2007  
 WO WO2007090292 A1 8/2007  
 WO WO2007094810 A2 8/2007  
 WO WO2008018002 A2 2/2008  
 WO WO2008027093 A2 3/2008  
 WO WO2008061991 A1 5/2008  
 WO WO2008110978 A1 9/2008  
 WO WO2008137460 A2 11/2008  
 WO WO2009061124 A2 5/2009  
 WO WO2009067074 A1 5/2009  
 WO WO2009111978 A1 9/2009  
 WO WO2009143047 A2 11/2009  
 WO WO2010014437 A2 2/2010  
 WO WO2010030509 A2 3/2010  
 WO WO2010047896 A3 4/2010  
 WO WO2010047898 A3 4/2010  
 WO WO2010047973 A3 4/2010  
 WO WO2010069983 A1 6/2010  
 WO WO2010083370 A2 7/2010  
 WO WO2010088105 A3 8/2010  
 WO WO2010132625 A2 11/2010  
 WO WO2010141537 A2 12/2010  
 WO WO2011005562 A2 1/2011  
 WO WO2011005579 A2 1/2011  
 WO 2011/021719 A1 2/2011  
 WO WO2011072308 A1 6/2011  
 WO WO2011113709 A2 9/2011  
 WO WO2011117059 A1 9/2011  
 WO WO2012001584 A1 1/2012  
 WO WO2012004708 A2 1/2012  
 WO WO2012007899 A1 1/2012  
 WO 2012/019535 A1 2/2012  
 WO WO2012025626 A1 3/2012  
 WO WO2012063174 A1 5/2012  
 WO WO2012117018 A1 9/2012  
 WO WO2012129301 A1 9/2012  
 WO WO2012131522 A1 10/2012  
 WO WO2012131547 A1 10/2012  
 WO WO2013028965 A2 2/2013  
 WO WO2013029960 A1 3/2013  
 WO WO2013030128 A2 3/2013  
 WO WO2013045255 A1 4/2013  
 WO WO2013045439 A1 4/2013  
 WO WO2013057660 A2 4/2013  
 WO WO2013079242 A1 6/2013  
 WO WO2013088299 A1 6/2013  
 WO 2013/097823 A1 7/2013  
 WO 2013/098700 A1 7/2013

## OTHER PUBLICATIONS

PLC-96973-PC PLC Lighting Elegance Modern/Contemporary Pendant Light, [online], [retrieved on Feb. 27, 2009] Retrieved from the Arcadian Lighting Web Page using Internet <URL: <http://www.arcadianlighting.com/plc-96978-pc.html>>.  
 Saha et al, "Location Determination of a Mobile Device using IEEE 802.11 Access Point Signals", May 5, 2002 in 20 pages.  
 Sensor Switch, nLight Lighting Control System, [online], [retrieved on Jan. 11, 2008] Retrieved from Sensor Switch web page using Internet <URL: <http://www.sensorswitch.com>>.  
 Six Strategies, [online], [retrieved on Jan. 11, 2008] Retrieved from Encelium Technologies Inc. Web Page using Internet <URL: <http://www.encelium.com/products/strategies.html>>.  
 Spencer, Eugene. High Sales, Low Utilization. Green Intelligent Buildings, Feb. 1, 2007. [online]. Retrieved from Green Intelligent Buildings web page using Internet <URL: [http://www.greenintelligentbuildings.com/CDA/IBT\\_Archive/BNP\\_GUID\\_9-5-2006\\_A\\_10000000000000056772](http://www.greenintelligentbuildings.com/CDA/IBT_Archive/BNP_GUID_9-5-2006_A_10000000000000056772)>.  
 Telecite Products & Services—Display Options, [online], [retrieved on Jan. 13, 2000] Retrieved from Telecite Web page using Internet <URL: <http://www.telecite.com/en/products/options.en.htm>>.  
 Traffic Signal Products—Transportation Products Group, [online], [retrieved on Jan. 13, 2000] Retrieved from the Dialight Web Page using Internet <URL: <http://www.dialight.com/trans.htm>>.

(56)

**References Cited****OTHER PUBLICATIONS**

Truck-Lite, LEDSelect—LED, Model 35, Clearance & Marker Lighting, [online], [retrieved on Jan. 13, 2000] Retrieved from Truck-Lite Web Page using Internet <URL: <http://trucklite.com/leds4.html>>.

Truck-Lite, LEDSelect—LED, Model 45, Stop, Turn & Tail Lighting [online], [retrieved on Jan. 13, 2000] Retrieved from Truck-Lite Web Page using Internet <URL: <http://trucklite.com/leds4.html>>.

Truck-Lite, LEDSelect—LED, Super 44, Stop, Turn & Tail Lighting, [online], [retrieved on Jan. 13, 2000] Retrieved from Truck-Lite Web Page using Internet <URL: <http://trucklite.com/leds2.html>>.

Wolsey, Robert. Interoperable Systems: The Future of Lighting Control, Lighting Research Center, Jan. 1, 1997, vol. 2 No. 2, Rensselaer Polytechnic Institute, Troy, New York [online]. Retrieved Lighting Research Center Web Page using Internet <URL: <http://www.lrc.rpi.edu/programs/Futures/LF-BAS/index.asp>>.

International Search Report and Written Opinion dated Feb. 15, 2013 from the corresponding International Application No. PCT/US2012/052244 filed on Aug. 24, 2012.

International Search Report and Written Opinion dated Aug. 30, 2011 for the corresponding International Application No. PCT/US2011/029994 filed Mar. 25, 2011.

Notification of Transmittal, the International Search Report and the Written Opinion of the International Searching Authority dated May 7, 2012, from the corresponding International Application No. PCT/US2011/064151.

Supplementary European Search Report for corresponding European Application No. 09822381.1 mailed Jan. 4, 2013 in 5 pages.

Supplementary European Search Report dated Feb. 22, 2012 from European Patent Application No. 09822424.9.

International Report on Patentability dated May 24, 2010 from the corresponding International Application No. PCT/US2009/060087 filed Oct. 9, 2009.

Extended European Search Report for co-pending European Application No. 10 73 2124 mailed on Dec. 13, 2012 in 8 pages.

Extended European Search Report for co-pending European Application No. 09822425.6 mailed on Aug. 30, 2012 in 9 pages.

Extended European Search Report for co-pending European Application No. 10797596.3 mailed on Jan. 17, 2013 in 11 pages.

Extended European Search Report for co-pending European Application No. 10736237.8 mailed on Oct. 19, 2012 in 5 pages.

Extended European Search Report for co-pending European Application No. 10738925.6 mailed on Oct. 1, 2012 in 7 pages.

Examination and Search Report mailed on Jul. 2, 2012 in coresponding United Kingdom Application No. 1018896.9 in 4 pages.

International Search Report and Written Opinion dated Jan. 4, 2010 from the corresponding International Application No. PCT/US2009/044313 filed May 18, 2009.

International Search Report and Written Opinion dated Feb. 7, 2011 from the corresponding International Application No. PCT/US2010/039678 filed Jun. 23, 2010.

International Search Report and Written Opinion dated May 7, 2010 from the corresponding International Application No. PCT/US2009/057109 filed on Sep. 16, 2009.

International Search Report and Written Opinion dated Apr. 8, 2010 from the corresponding International Application No. PCT/2009/055114 filed on Aug. 27, 2009.

International Search Report and Written Opinion dated Feb. 8, 2011 from the corresponding International Application No. PCT/US2010/039608 filed Jun. 23, 2010.

International Search Report and Written Opinion dated Dec. 13, 2010 from the corresponding International Application No. PCT/US2010/037006 filed Jun. 2, 2010.

International Search Report and Written Opinion dated Mar. 13, 2012 from the corresponding International Application No. PCT/US2011/052995 filed on Sep. 23, 2011.

International Search Report and Written Opinion dated May 14, 2010 from the corresponding International Application No. PCT/US2009/060085 filed Oct. 9, 2009.

International Search Report and Written Opinion dated Aug. 16, 2010 from the corresponding International Application No. PCT/US2010/021131 filed on Jan. 15, 2010.

International Search Report and Written Opinion dated Jul. 16, 2009 from the corresponding International Application No. PCT/US2008/084650 filed Nov. 25, 2008.

International Search Report and Written Opinion dated Aug. 17, 2010 from the corresponding International Application No. PCT/US2010/021489 filed on Jan. 20, 2010.

International Search Report and Written Opinion dated Jul. 17, 2009 from the corresponding International Application No. PCT/US2008/085118 filed Dec. 1, 2008.

International Search Report and Written Opinion dated Nov. 21, 2011 from the corresponding International Application No. PCT/US2011/029932 filed on Mar. 25, 2011.

International Search Report and Written Opinion dated Mar. 22, 2010 from the corresponding International Application No. PCT/US2009/053853 filed Aug. 14, 2009.

International Search Report and Written Opinion dated Nov. 23, 2011 from the corresponding International Application No. PCT/US2011/042761 filed on Jul. 1, 2011.

International Search Report and Written Opinion dated Nov. 23, 2011 from the corresponding International Application No. PCT/US2011/042775 filed on Jul. 1, 2011.

International Search Report and Written Opinion dated Dec. 24, 2010 from the corresponding International Application No. PCT/US2010/034635 filed May 13, 2010.

International Search Report and Written Opinion dated May 24, 2010 from the corresponding International Application No. PCT/2009/060083 filed Oct. 9, 2009.

Notification of Transmittal, the International Search Report and the Written Opinion of the International Searching Authority dated May 7, 2012 from the corresponding International Application No. PCT/US2011/058312.

International Search Report and Written Opinion dated Aug. 25, 2009 from corresponding International Application No. PCT/US2009/031049 filed Jan. 15, 2009.

International Search Report and Written Opinion dated Jan. 25, 2010 from the corresponding International Application No. PCT/US2009/048623 filed Jun. 25, 2009.

International Search Report and Written Opinion dated Feb. 26, 2010 from the corresponding International Application No. PCT/US2009/050949 filed Jul. 17, 2009.

International Search Report and Written Opinion dated Apr. 30, 2010 from the corresponding International Application No. PCT/US2009/057072 filed on Sep. 16, 2009.

International Search Report and Written Opinion dated Jul. 30, 2010 from the corresponding International Application No. PCT/US2010/021448 filed on Jan. 20, 2010.

International Search Report and Written Opinion dated Sep. 30, 2011 from the corresponding International Application No. PCT/US2011/029905 filed on Mar. 25, 2011.

Best Practice Guide—Commercial Office Buildings—Central HVAC System. [online], [Retrieved on Jan. 17, 2008] Retrieved from Flex Your Power Organization web page using Internet <URL: <http://www.fypower.org/bpg/module.html?b=offices&m=Central HVAC Systems&s=Contr...>>.

International Search Report and Written Opinion dated Feb. 9, 2012 from the corresponding International Application No. PCT/US2011/043524 filed on Jul. 11, 2011.

Airport International. Fly High With Intelligent Airport Building and Security Solutions [online], [retrieved on Oct. 24, 2008]. Retrieved from Airport International web page using Internet <URL: <http://www.airport-int.com/categories/airport-building-and-security-solutions/fly-high-with-intelligent-airport-building-and-security-solutions.html>>.

Cornell University. Light Canopy—Cornell University Solar Decathlon, [online], [retrieved on Jan. 17, 2008] Retrieved from Cornell University web page using Internet <URL: <http://cusd.cornell.edu/cusd/web/index.php/page/show/section/Design/page/controls>>.

D.N.A.-III, [online], [retrieved Mar. 10, 2009] Retrieved from the PLC Lighting Web Page using Internet <URL: [http://www.plclighting.com/product\\_info.php?cPath=1&products\\_id=92](http://www.plclighting.com/product_info.php?cPath=1&products_id=92)>.

(56)

**References Cited****OTHER PUBLICATIONS**

E20112-22 Starburst Collection, [online], [retrieved on Jul. 10, 2010] Retrieved from ET2 Contemporary Lighting using Internet <URL: <http://www.et2online.com/proddetail.aspx?ItemID=E20112-22>>.

E20116-18 Larmes Collection, [online], [retrieved on Jul. 10, 2010] Retrieved from ET2 Contemporary Lighting using Internet <URL: <http://www.et2online.com/proddetail.aspx?ItemID=E20116-18>>.

E20524-10 & E20525-10 Curva Collection, [online], [retrieved on Jul. 10, 2010] Retrieved from ET2 Contemporary Lighting using Internet <URL: <http://www.et2online.com/proddetail.aspx?ItemID=E20524-10 & E20525-10>>.

E20743-09 Stealth Collection, [online], [retrieved on Jul. 10, 2010] Retrieved from ET2 Contemporary Lighting using Internet <URL: <http://www.et2online.com/proddetail.aspx?ItemID=E20743-09>>.

E22201-44 Esprit Collection, [online], [retrieved on Jul. 10, 2010] Retrieved from ET2 Contemporary Lighting using Internet <URL: <http://www.et2online.com/proddetail.aspx?ItemID=E22201-44>>.

Experiment Electronic Ballast. Electronic Ballast for Fluorescent Lamps [online], Revised Fall of 2007. [Retrieved on Sep. 1, 1997]. Retrieved from Virginia Tech Web Page using Internet <URL: <http://www.ece.vt.edu/ece3354/labs/ballast.pdf>>.

Henson, Keith. The Benefits of Building Systems Integration, Access Control & Security Systems Integration, Oct. 1, 2000, Penton Media. [online], [retrieved on Oct. 24, 2008] Retrieved from Security Solutions Web page using Internet <URL: [http://securitysolutions.com/mag/security\\_benefits\\_building\\_systems/](http://securitysolutions.com/mag/security_benefits_building_systems/)>.

Hightower et al, "A Survey and Taxonomy of Location Systems for Ubiquitous Computing", University of Washington, Computer Sci-

ence and Engineering, Technical Report UW-CSE Jan. 8, 2003, IEEE, Aug. 24, 2001 in 29 pages.

Lawrence Berkeley National Laboratory. Lighting Control System—Phase Cut Carrier. University of California, [online] [retrieved on Jan. 14, 2008] Retrieved from Lawrence Berkeley National Laboratory web page using Internet <URL: <http://www.lbl.gov/tt/techs/lbn11871.html>>.

LCD Optics 101 Tutorial [online]. 3M Corporation, [retrieved on Jan. 6, 2010]. Retrieved from the internet: <URL: [http://solutions.3m.com/wps/porta1/3M/en\\_US/Vikuiti1/BrandProducts/secondary/optics101/](http://solutions.3m.com/wps/porta1/3M/en_US/Vikuiti1/BrandProducts/secondary/optics101/)>.

LED Lights, Replacement LED lamps for any incandescent light, [online], [retrieved on Jan. 13, 2000] Retrieved from LED Lights Web Page using Internet <URL: <http://www.ledlights.com/replac.htm>>.

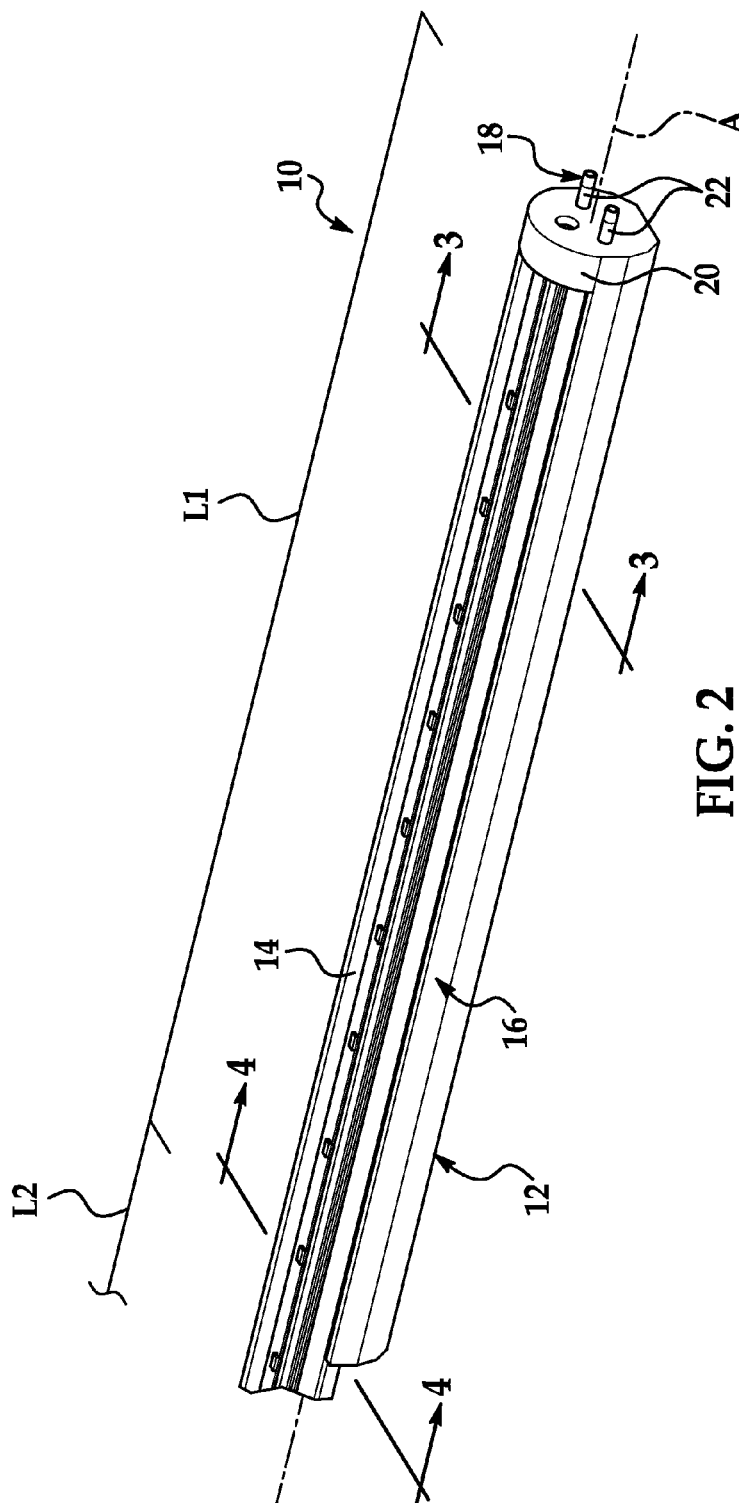
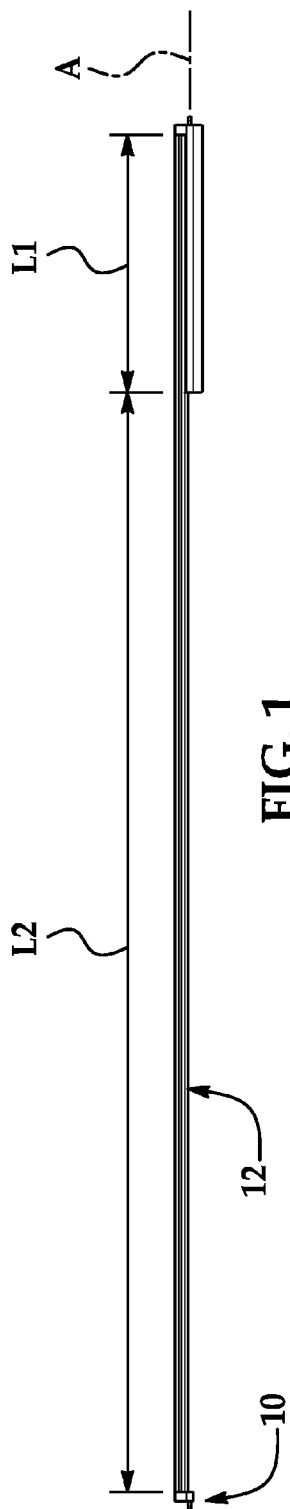
LEDtronic, LEDtronic Catalog, 1996, p. 10, LEDtronics, Torrance, California.

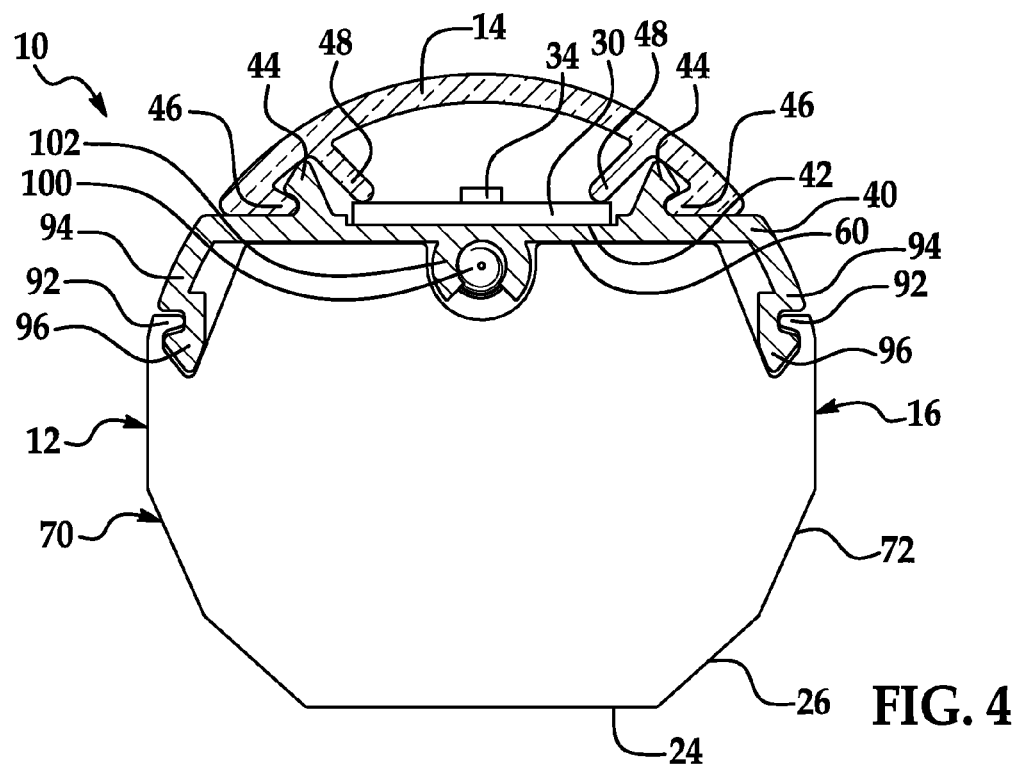
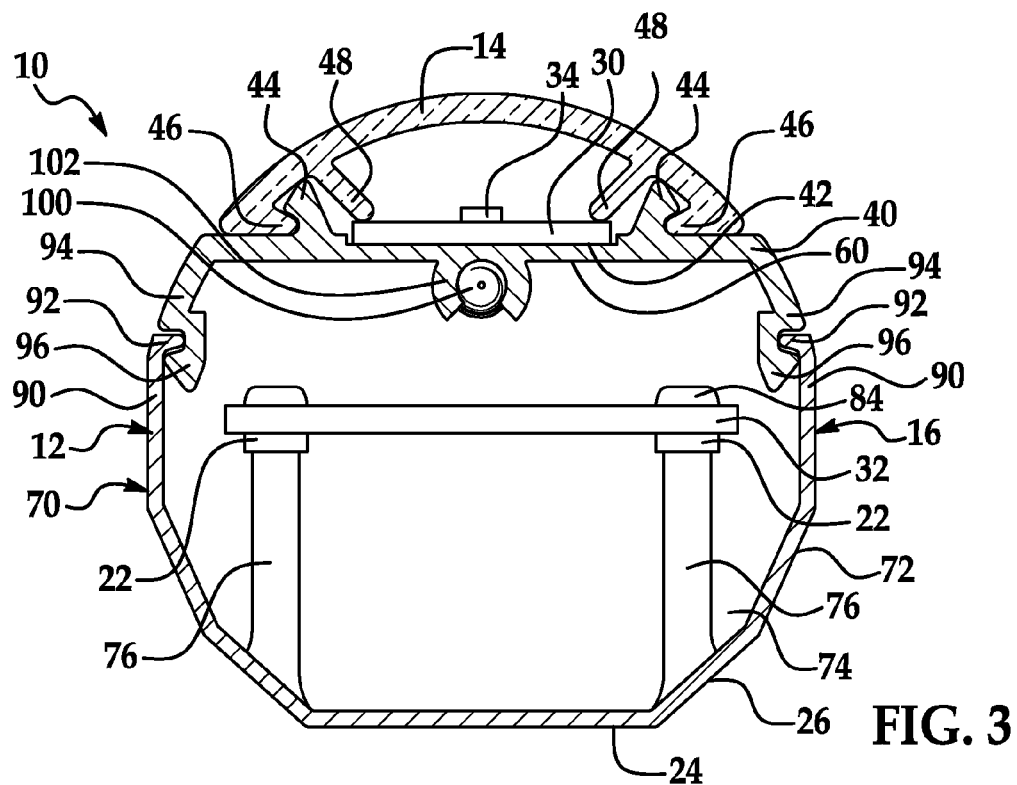
Phason Electronic Control Systems, Light Level Controller (LLC) case study. Nov. 30, 2004. 3 pages, Phason Inc., Winnipeg, Manitoba, Canada.

Philips. Sense and Simplicity—Licensing program for LED Luminaires and Retrofits, Philips Intellectual Property & Standards, May 5, 2009.

Piper. The Best Path to Efficiency. Building Operating Management, Trade Press Publishing Company May 2000 [online], [retrieved on Jan. 17, 2008]. Retrieved from Find Articles Web Page using Internet <URL: [http://findarticles.com/p/articles/mi\\_qu3922/is\\_200005/ai\\_n8899499/](http://findarticles.com/p/articles/mi_qu3922/is_200005/ai_n8899499/)>.

\* cited by examiner





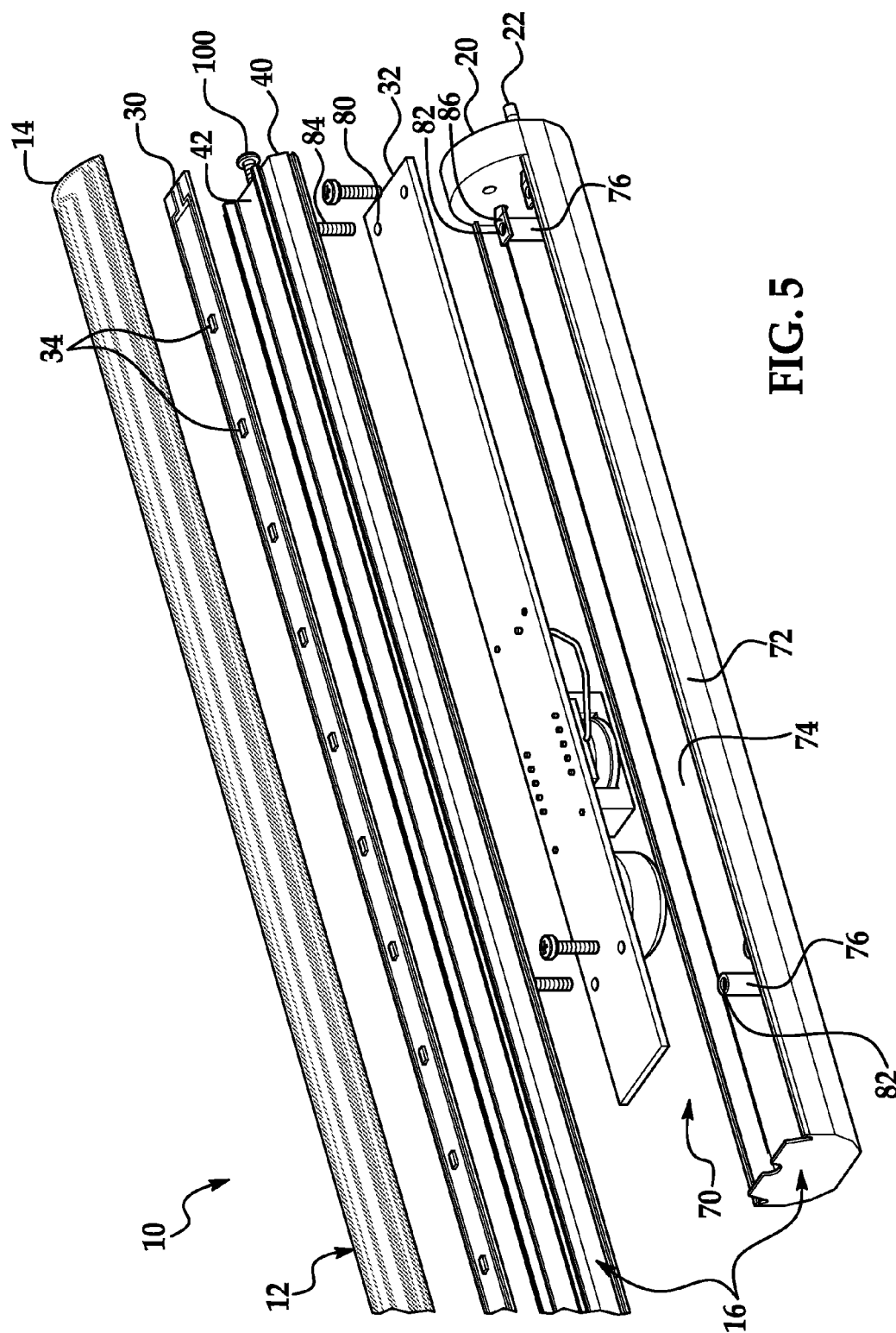


FIG. 5

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**POWER SUPPLY ASSEMBLY FOR  
LED-BASED LIGHT TUBE****CROSS REFERENCE TO RELATED  
APPLICATION**

This application claims priority benefit to U.S. Provisional Patent Application No. 61/668,720 filed Jul. 6, 2012, the contents of which is hereby incorporated by reference in its entirety.

**TECHNICAL FIELD**

The embodiments disclosed herein relate in general to a light emitting diode (LED)-based light for replacing a conventional light in a standard fluorescent light fixture, and in particular to an LED-based light including a power supply assembly.

**BACKGROUND**

Fluorescent lights may be used in a variety of locations, such as schools and commercial buildings and residential dwellings. Although fluorescent lights may have certain advantages over, for example, incandescent lights, they may also pose certain disadvantages including, inter alia, disposal problems due to the presence of potentially toxic materials within the light.

LED-based lights designed as one-for-one replacements for fluorescent tube lights have appeared in recent years. These LED-based lights can define a housing that includes circuitry configured to condition power received from a power supply to a power usable to operate the LEDs of the LED-based light.

**SUMMARY**

Disclosed herein are embodiments of LED-based lights. In one aspect, an LED-based light for replacing a fluorescent light in a light fixture comprises: an elongate housing, the housing having a first longitudinal portion with a first cross section and a second longitudinal portion adjoining the first longitudinal portion with a second cross section, wherein a shape of the first cross section is different from a shape of the second cross section, such that the housing includes at least one geometric asymmetry; at least one LED arranged in the housing; and a connector at an end of the housing configured for connection to a light fixture.

In another aspect, an LED-based light for replacing a fluorescent light in a light fixture comprises: an elongate base defining a first surface and an opposing second surface; an LED circuit board supported on the first surface of the base, the LED circuit board including at least one LED; a light transmitting lens attached to the base to enclose the LED-circuit board, the lens extending a substantial length of the base; a power supply circuit board located adjacent the second surface of the base, the power supply circuit board configured to supply power to the at least one LED; and a cover attached to the base to enclose the power supply circuit board, the cover extending only a partial length of the base.

In yet another aspect, an LED-based light for replacing a fluorescent light in a light fixture comprises: an elongate base; an LED circuit board supported on the base, the LED circuit board including at least one LED; a light transmitting lens attached to the base to enclose the LED-circuit board; and a power supply assembly selectively removably attached to the

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base, the power supply assembly including power supply circuitry configured to supply power to the at least one LED.

These and other aspects will be described in additional detail below.

**BRIEF DESCRIPTION OF THE DRAWINGS**

The various features, advantages and other uses of the present apparatus will become more apparent by referring to the following detailed description and drawings in which:

FIG. 1 is a side plan view of an exemplary LED-based light;

FIG. 2 is a partial perspective view of the LED-based light of FIG. 1;

FIGS. 3 and 4 are section views of the LED-based light of FIG. 1; and

FIG. 5 is an exploded partial perspective view of the LED-based light of FIG. 1 showing a power supply assembly.

**DETAILED DESCRIPTION**

The embodiments of an LED-based light described herein include a unique housing configuration and a novel power supply assembly configured to condition a power received from a power supply to a power usable to operate the LEDs of the LED-based light.

FIG. 1 illustrates an exemplary LED-based light **10** for replacing a conventional light in a light fixture. The light fixture can be designed to accept conventional fluorescent lights, such as T5, T8 or T12 fluorescent tube lights, or can be designed to accept non-standard fluorescent lights, such as lights installed by an electrician. The fixture can connect to a power source, and may include a ballast electrically connected between the power source and LED-based light **10**.

A perimeter boundary of the LED-based light **10** defines a housing **12** for housing components of the LED-based light **10**. The illustrated housing **12** is an elongated housing extending along a longitudinal axis **A** of the LED-based light **10**. Although the housing **12** is illustrated as an elongated linear housing extending along a linear longitudinal axis **A**, housings having alternative longitudinal shapes, e.g., U-shaped or circular shaped housings, can alternatively be used. The LED-based light **10** can have any suitable length. For example, the LED-based light **10** may be approximately 48" long, and the housing **12** can have a 0.625", 1.0" or 1.5" diameter for engagement with a standard fluorescent light fixture.

The housing **12** can have one or more cross sectional shapes. For example, cylindrical, square, triangular, polygonal, or other cross sectional shapes can be used for the housing **12**. The housing **12** can have a uniform lengthwise cross sectional shape, or as shown in FIG. 1, the housing **12** can have a cross sectional shape that varies at different points along the longitudinal axis **A**.

The housing **12** of the LED-based light **10** generally extends a length along the longitudinal axis **A**, and can include multiple partial lengths, for example, a first partial length **L1** and a second partial length **L2**. In the illustrated the housing **12**, each of the partial lengths **L1** and **L2** includes at least one portion with a cross sectional shape different from the cross sectional shape of a portion of an adjoining partial length. For example, the housing **12** of the LED-based light **10** shown in FIG. 1 generally extends a length along the longitudinal axis **A**, with the first partial length **L1** of the housing **12** having a first cross sectional shape, and with the second partial length **L2** of the housing **12** having a second cross sectional shape different from the first cross sectional

shape. In the illustrated exemplary implementation of the LED-based light 10, the housing 12 has two partial lengths L1 and L2, with each of the illustrated partial lengths L1 and L2 of the housing 12 being continuous along the longitudinal axis A and having substantially constant respective cross sectional shapes. In addition, the illustrated partial lengths L1 and L2 adjoin each other to substantially extend an entire length of the housing 12. However, the housing 12 could have multiple other partial lengths, each having a portion with a differing cross sectional shape as compared to one or more respective adjoining partial lengths. In addition, the partial lengths need not be discrete, with constant cross sectional shapes. For example, the cross sectional shapes of one or more partial lengths of the housing 12 could be continuously variable.

The LED-based light 10, having a housing 12 with a cross sectional shape that varies at different points along the longitudinal axis A, can define one or more asymmetries. For example, the housing 12 shown in FIG. 1 is asymmetric about an imaginary plane normal to the longitudinal axis A of the housing 12 and positioned approximate a midpoint of the length of the housing 12. Depending upon its configuration, the housing 12 having a cross sectional shape that varies at different points along its longitudinal axis A could alternatively be symmetric about the above described imaginary plane but include one or more other geometric asymmetries. However, the housing 12 could also generally be geometrically symmetrical.

The housing 12 of the LED-based light 10 can at least partially be defined by an exterior part of a light transmitting portion. For example, with reference to FIG. 2, the housing 12 of the LED-based light 10 is at least partially defined by the exterior of a high dielectric light transmitting lens 14. The lens 14 can be made from polycarbonate, acrylic, glass or other light transmitting material (i.e., the lens 14 can be transparent or translucent). The term "lens" as used herein means a light transmitting structure, and not necessarily a structure for concentrating or diverging light.

The LED-based light 10 can include features for uniformly distributing light to an environment to be illuminated in order to replicate the uniform light distribution of a conventional fluorescent light. For example, the lens 14 can be manufactured to include light diffracting structures, such as ridges, dots, bumps, dimples or other uneven surfaces formed on an interior or exterior of the lens 14. The light diffracting structures can be formed integrally with the lens 14, for example, by molding or extruding, or the structures can be formed in a separate manufacturing step such as surface roughening. In addition to or as an alternative to light diffracting structures, a light diffracting film can be applied to the exterior of the lens 14 or placed in the housing 12, or, the material from which the lens 14 is formed can include light refracting particles. For example, the lens 14 can be made from a composite, such as polycarbonate, with particles of a light refracting material interspersed in the polycarbonate. In other embodiments, the LED-based light 10 may not include any light diffracting structures or film.

The housing 12 of the LED-based light 10 is at least partially defined by the exterior of the lens 14. The remainder of the housing 12 can generally be defined by the exterior of a lower portion 16 positioned opposite the lens 14. The lower portion 16 could be integral with the lens 14. For example, the housing 12 could include a light transmitting tube at least partially defined by the lens 14 and at least partially defined by a lower portion 16. The housing 12 may be formed by attaching multiple individual parts, not all of which need be light transmitting. For example, the housing 12 may be

formed by attaching the lens 14 to an opaque lower portion 16. The lower portion 16 could be formed from a single part, or, as described below, can be formed from multiple parts that collectively partially define the housing 12.

With continued reference to FIG. 2, the LED-based light 10 can include an electrical connector 18 positioned at an end of the housing 12. In the illustrated example, the electrical connector 18 is a bi-pin connector carried by an end cap 20. A pair of end caps 20 can be attached at opposing longitudinal ends of the housing 12 for physically connecting the LED-based light 10 to a fluorescent light fixture. The end caps 20 can be the sole physical connection between the LED-based light 10 and the fixture. At least one of the end caps 20 can additionally electrically connect the LED-based light 10 to the fixture to provide power to the LED-based light 10. Each end cap 20 can include two pins 22. Two of the total four pins may be configured as bi-pin electrical connector 18 and the other two pins can be "dummy pins" that provide physical but not electrical connection to the fixture. Bi-pin electrical connector 18 is compatible with variously configured fluorescent fixtures, although other types of electrical connectors can be used, such as single pin connector or screw type connector.

The housing 12 of the LED-based light 10 is generally defined by the lens 14 and the lower portion 16 opposing the lens 14 as it extends a length along the longitudinal axis A. The cross section of the housing 12 at a point along the longitudinal axis A is likewise circumferentially defined by the lens 14 and the lower portion 16 opposing the lens 14. The housing 12 can have a cross sectional shape that varies at different points along the longitudinal axis A. For example, the housing 12 may include the lens 14 having a generally constant outer profile extending along the longitudinal axis A, and the lower portion 16 having a cross sectional shape that varies along the longitudinal axis A, such that the housing 12, circumferentially defined partially by the lens 14 and partially by the lower portion 16 opposing the lens 14, is an elongated housing 12 having a varying cross section along the longitudinal axis A.

Other configurations for the lens 14 and/or lower portion 16 could be used to define the housing 12. For example, the lens 14 could have a cross sectional shape that varies along the longitudinal axis A, with the lower portion 16 having a generally constant cross sectional shape along the longitudinal axis A. Or, both the lens 14 and the lower portion 16 could have cross sectional shapes that vary along the longitudinal axis A. Alternatively, the housing 12 could include components other than lens 14 and the lower portion 16 that function to define, either alone or in some combination with the lens 14 and/or lower portion 16, a housing 12 with a cross sectional shape that varies at different points along the longitudinal axis A.

Exemplary cross sections of the housing 12 along the longitudinal axis A are illustrated in FIGS. 3 and 4. The cross section of the LED-based light 10 at a portion along the first partial length L1 of the housing 12 is taken along the line 3-3 of FIG. 2 and illustrated in FIG. 3. As illustrated in FIG. 3, along the first partial length L1, the lens 14 has an arcuate cross section, and the lower portion 16 opposing the lens 14 has a substantially C-shaped cross section, such that the housing 12 has a substantially circular cross section along the first partial length L1 of the housing 12. The substantially circular cross section could be curvilinear, or as shown in FIG. 3, could be defined by the housing 12 including one or more flat surfaces, for instance, a number of adjoining flat longitudinally extending surfaces, such as the exemplary surfaces 24 and 26.

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The cross section of the LED-based light **10** at a portion along the second partial length **L2** of the housing **12** is taken along the line **4-4** of FIG. **2** and illustrated in FIG. **4**. As shown in FIG. **4**, the cross section of the housing **12** along the second partial length **L2** is different from the cross section of the housing **12** along the first partial length **L1**. That is, while the housing **12** has a substantially circular cross section along the first partial length **L1**, the housing **12** has a non-circular cross section along the second partial length **L2**. The illustrated lens **14** has a generally constant arcuate cross section along the length of the housing **12**, including both the first partial length **L1** and second partial length **L2**. Along the second partial length **L2**, the lower portion **16** opposing the arcuate lens **14** has a substantially flat cross section, such that the housing **12** has a generally bow-shaped cross section along the second partial length **L2** of the housing **12**.

With reference to FIGS. **3-5**, the housing **12** of the LED-based light **10** can house a number of components. For example, one or more circuit boards **30** and **32** are illustrated as supported within the housing **12**. The circuit board **30** can be an LED circuit board having at least one LED circuit. The LED circuit board **30** can include at least one LED **34**, a plurality of series-connected or parallel-connected LEDs **34**, an array of LEDs **34** or any other arrangement of LEDs **34**. Each of the LEDs **34** can include a single diode or multiple diodes, such as a package of diodes producing light that may appear to an ordinary observer as coming from a single source. The LEDs **34** can be surface-mount devices of a type available from Nichia, although other types of LEDs can alternatively be used. For example, the LED-based light **10** can include high-brightness semiconductor LEDs, organic light emitting diodes (OLEDs), semiconductor dies that produce light in response to current, light emitting polymers, electro-luminescent strips (EL) or the like.

The LEDs **34** may emit white light or light having a range of wavelengths. LEDs that emit blue light, ultra-violet light or other wavelengths of light can be used in place of or in combination with white light emitting LEDs **34**. The number, spacing and orientation of the LEDs **34** can be a function of a length of the LED-based light **10**, a desired lumen output of the LED-based light **10**, the wattage of the LEDs **34** and/or the viewing angle of the LEDs **34**. For a 48" LED-based light **10**, for example, the number of LEDs **34** may vary from about thirty to sixty such that the LED-based light **10** outputs approximately 3,000 lumens. However, a different number of LEDs **34** can alternatively be used, and the LED-based light **10** can output any other amount of lumens. The LEDs **34** can be evenly spaced along the LED circuit board **30** and arranged on the LED circuit board **30** to substantially fill a space along a length of the lens **14** between end caps **20** positioned at opposing longitudinal ends of the housing **12**. Alternatively, single or multiple LEDs **34** can be located at one or both ends of the LED-based light **10**. The LEDs **34** can be arranged in a single longitudinally extending row along a central portion of the LED circuit board **30**, for example, as shown in FIG. **2**, or can be arranged in a plurality of rows or arranged in groups. The spacing of the LEDs **34** can be determined based on, for example, the light distribution of each LED **34** and the number of LEDs **34**.

The circuit board **32** can be a power supply circuit board. The power supply circuit board **32** has power supply circuitry configured to condition an input power received from, for example, the fixture through the electrical connector **18** to a power usable by and suitable for the LEDs **34**. In some implementations, the power supply circuit board **32** can include one or more of an inrush protection circuit, a surge suppressor circuit, a noise filter circuit, a rectifier circuit, a main filter

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circuit, a current regulator circuit and a shunt voltage regulator circuit. The power supply circuit board **32** can be suitably designed to receive a wide range of currents and/or voltages from a power source and convert them to a power usable by the LEDs **34**.

The LED circuit board **30** and the power supply circuit board **32** are illustrated as elongate printed circuit boards. Multiple circuit board sections can be joined by bridge connectors to create the circuit boards **30** and **32**. Also, other types of circuit boards may be used, such as a metal core circuit board. Or, instead of the circuit boards **30** and **32**, other types of electrical connections (e.g., wires) can be used to electrically connect the LEDs **34** to a power source.

Both the LED circuit board **30** and the power supply circuit board **32** can be positioned to extend along the longitudinal axis **A** of the LED-based light **10**. With continued reference to FIG. **5**, the LED circuit board **30** can have a length different from a length of the power supply circuit board **32**. For example, the LED circuit board **30** can generally extend the length of the housing **12**, and the power supply circuit board **32** can extend a partial length of the housing **12**, for instance, the first partial length **L1** of the housing **12**.

The LED circuit board **30** may be a separate component from the power supply circuit board **32**, and the LED circuit board **30** can be housed separately from the power supply circuit board **32**. The LED circuit board **30** is positioned adjacent the lens **14**, such that the LEDs **34** included in the LED circuit board **30** are oriented to illuminate the lens **14**. The power supply circuit board **32** can be housed elsewhere within the housing **12** of the LED-based light **10**, for example, within a cavity defined by the lower portion **16**.

The LED-based light **10** can include features for supporting the circuit boards **30** and **32** within the housing **12**, and/or for supporting other components of the LED-based light **10**. For example, the LED-based light **10** can include an elongate base **40**. The elongate base **40** can extend the length of the housing **12** and include an LED mounting surface **42** for supporting the LED circuit board **30** within the housing **12** adjacent the lens **14**. The LED mounting surface **42** may be substantially flat, so as to engage a flat underside of the LED circuit board **30** opposite the LEDs **34**.

The elongate base **40** can be further configured for attachment with the lens **14**. For example, the elongate base **40** may include a pair of hooked projections **44** for retaining a corresponding pair of respective projections **46** of the lens **14**. The projections **46** of the lens **14** can be slidably engaged with the hooked projections **44** of the elongate base **40**, or can be snap fit to the hooked projections **44**. The hooked projections **44** can be formed integrally with the elongate base **40** by, for example, extruding the elongate base **40** to include the hooked projections **44**. Similarly, the projections **46** can be formed integrally with the lens **14** by, for example, extruding the lens **14** to include the projections **46**. The hooked projections **44** and projections **46** can extend the longitudinal lengths of the elongate base **40** and the lens **14**, respectively, although a number of discrete hooked projections **44** and/or projections **46** could be used to couple the lens **14** to the elongate base **40**. Alternatively, the elongate base **40** could be otherwise configured for attachment with the lens **14**. For example, the lens **14** could be clipped, adhered, snap- or friction-fit, screwed or otherwise attached to the elongate base **40**.

The lens **14** can include one or more structures for securing the LED circuit board **30** within the housing **12** of the LED-based light **10**. For example, lens **14** may include tabs **48** for securing the LED circuit board **30** to the LED mounting surface **42** of the elongate base **40**. The tabs **48** are illustrated

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as projecting from the lens 14 at an angle towards the LED circuit board 30 to contact the LED circuit board 30 along its longitudinal length and prevent disengagement of the LED circuit board 30 from the LED mounting surface 42. The tabs 48 can be formed integrally with the lens 14 by, for example, extruding the lens 14 to include the tabs 48. Each of the tabs 48 can extend a longitudinal length of the lens 14, although a number of discrete tabs 48 could be included along the longitudinal length of the lens 14 to secure the LED circuit board 30 to the LED mounting surface 42 of the elongate base 40. Although the tabs 48 are illustrated as projecting at an angle from the lens 14, the tabs 48 could alternatively project at other angles and/or from other structures within the LED-based light 10, for example from the elongate base 40. In addition to or as an alternative to the tabs 48, the LED circuit board 30 could be secured within the housing 12 through slidable engagement with one or more structures of the LED-based light 10, such as the end cap 20, or the LED circuit board 30 could alternatively be clipped, adhered, snap- or friction-fit, screwed or otherwise secured within the housing 12.

The illustrated elongate base 40 further includes a surface 60 opposite the LED mounting surface 42 and opposing the lens 14. The surface 60 is shown as a substantially flat surface, but could have other geometries, and can include structures for coupling with other components of the LED-based light 10. The surface 60 may form a part of the lower portion 16 of the housing 12 for the LED-based light 10 along a partial length of the housing 12. For example, the surface 60 can form a part of the lower portion 16 of the housing 12 along the second partial length L2 of the housing 12. When the surface 60 of the elongate base 40 is positioned to oppose the lens 14 with a substantially arcuate cross section, the housing 12 has the generally bow-shaped cross section shown in FIG. 4 along the second partial length L2.

The LED-based light 10 can include one or more highly thermally conductive structures for enhancing heat dissipation. For instance, the elongate base 40 could be configured as a heat sink. The elongate base 40 can be constructed from a thermally conductive material for thermally coupling the LEDs 34 to an ambient environment surrounding the LED-based light 10. The elongate base 40 may form the LED mounting surface 42, which can be configured for thermal coupling to the LEDs 34. In the LED-based light 10, for example, the LED mounting surface 42 is thermally coupled to the LEDs 34 through the LED circuit board 30, although the LEDs 34 could be otherwise thermally coupled to the LED mounting surface 42. The LED mounting surface 42 may be substantially flat, so as to engage a flat underside of the LED circuit board 30 in a thermally conductive relation. The elongate base 40 can define a heat transfer path from the LED mounting surface 42 to the surface 60, which can be configured as a heat dissipating surface for dissipating heat generated by the LEDs 34 during operation to the ambient environment surrounding the LED-based light 10. The surface 60 may be the substantially flat surface 60, although the surface 60 could alternatively include other geometries and/or structures for increasing the surface area of the surface 60, such as bends, fins or other projections.

The elongate base 40 can also be configured to support the power supply circuit board 32 within the housing 12 of the LED-based light 10. For example, the elongate base 40 of the LED-based light 10 can be configured for attachment to a power supply assembly 70 including the power supply circuit board 32. The power supply assembly 70 may generally include power supply circuitry configured to condition an input power received from a fixture or other power supply to

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a power usable to operate the LEDs 34. The power supply circuitry for the LED-based light 10 may be included in the power supply circuit board 32.

The power supply assembly 70 may include a cover 72 for housing and enclosing the power supply circuit board 32. The cover 72 defines a hollow cavity 74 for housing the power supply circuit board 32, and can be configured to support the power supply circuit board 32 within the cavity 74. In addition, the cover 72 can include structures for selectively and/or releasably attaching the power supply circuit board 32 to the cover 72. Various means of attachment can be used for selectively and/or releasably attaching the power supply circuit board 32 to the cover 72. In the illustrated example, the cover 72 includes a plurality of posts 76 generally forming a platform for supporting the power supply circuit board 32 within the cavity 74 of the cover 72. The power supply circuit board 32 can define one or more apertures 80 positioned for alignment with corresponding apertures 82 defined by the post (one representative aperture 80 and one representative aperture 82 are indicated with respective reference numerals). The apertures 80 are defined adjacent corners of the power supply circuit board 32, but could be positioned elsewhere on the power supply circuit board 32. The apertures 80 defined by the power supply circuit board 32 can be sized to receive a threaded fastener 84, and the apertures 82 defined by the posts 76 can be configured for threadedly receiving the threaded fastener 84 to attach the power supply circuit board 32 to the cover 72. The power supply circuit board 32 could alternatively be supported within the cover 72 through slidable engagement with a part of the cover 72, or the power supply circuit board 32 could be clipped, adhered, snap- or friction-fit, screwed or otherwise coupled to the cover 72.

The power supply assembly 70 can also include an electrical connection to electrically couple the power supply circuit board 32 to the electrical connector 18 (see for example, FIG. 2) configured to electrically connect the LED-based light 10 to a fixture in order to provide power to the LED-based light 10. For example, one or more of the threaded fasteners 84 adjacent an end cap 20 can be electrically conductive and be used to provide an electrical connection between the power supply circuitry included in the power supply circuit board 32 and one or more of the pins 22 of the end cap 20. Referring to FIG. 5, two pins 22 extend through the end cap 20 to the hollow cavity 74 enclosed by the cover 72. The portion of the pins 22 extending through the end cap 20 can define pin apertures 86 positioned generally in alignment with corresponding apertures 80 and 82 respectively defined by the power supply circuit board 32 and the posts 76. Each of the pin apertures 86 can be sized to receive a threaded fastener 84. Further, the pin apertures 86 and the apertures 80 defined by the power supply circuit board 32 can be sized to engage the threaded fastener 84 in electrically conductive relation, such that a pin 22 and the power supply circuitry include in the power supply circuit board 32 are electrically connected through the threaded fastener 84.

The power supply assembly 70 could be included in the LED-based light 10 by integrally forming the cover 72 with the elongate base 40, for example. In the illustrated exemplary implementation of the LED-based light 10, the power supply assembly 70 is releasably coupled to the LED-based light 10. The power supply assembly 70 may be a modular component that can be selectively and releasably attached to the LED-based light 10.

The cover 72 of the power supply assembly 70 may be configured for selective and releasable attachment to the elongate base 40 of the LED-based light 10. The cover 72 may be generally C-shaped, with opposing longitudinally extending

side walls 90 terminating at a respective pair of terminal edges forming projections 92. The surface 60 of the elongate base 40 may include a pair of opposing flanges 94 extending from the longitudinal edges of the surface 60 in a direction away from the lens 14, and each flange 94 forms a hooked projection 96 for retaining a corresponding projection 92 of the cover 72. The projections 92 of the cover 72 can be slidably engaged with the hooked projections 96 of the elongate base 40, or can be snap fit to the hooked projections 96. The hooked projections 96 can be formed integrally with the elongate base 40 by, for example, extruding the elongate base 40 to include the flanges 94 with hooked projections 96. Similarly, the projections 92 can be formed integrally with the cover 72 by, for example, extruding the cover 72 to include the projections 92. The hooked projections 96 and projections 92 can extend the longitudinal lengths of the elongate base 40 and the cover 72, respectively, although a number of discrete hooked projections 96 and/or projections 92 could be used to couple the cover 72 to the elongate base 40. Alternatively, the cover 72 could be otherwise configured for attachment to the elongate base 40. For example, the cover 72 could be configured to be clipped, adhered, snap- or friction-fit, screwed or otherwise attached to the elongate base 40.

The cover 72 can be enclosed at each longitudinal end. For example, the cover 72 may be enclosed at a longitudinal end adjacent a longitudinal end of the housing 12 by the end cap 20. The cover 72 can be integral with the end cap 20, or the cover 72 and the end cap 20 could be separate components, with a longitudinal end of the cover 72 sized to abut the end cap 20. The illustrated end cap 20 can be affixed to the housing 12 by threadedly engaging a threaded fastener 100 through the end cap 20 and into a groove 102 formed in the elongate base 40. The groove 102 extends from the surface 60 of the elongate base 40, but could alternatively extend from other portions of the elongate base 40 or from other components of the housing 12. The end cap 20 could alternatively be clipped, adhered, snap- or friction-fit, screwed or otherwise attached to the elongate base 40. The illustrated cover 72 is integral with the end cap 20, and affixation of the end cap 20 to the elongate base 40 secures the cover 72 to the LED-based light 10.

The elongate base 40 includes the surface 60, which may form at least a part of the lower portion 16 of the housing 12 of the LED-based light 10. Absent attachment of the power supply assembly 70, for example, the surface 60 could form substantially the entire lower portion 16 of the housing 12, such that the cross section of the housing 12 is generally defined by the lens 14 and by the surface 60 of the elongate base 40 positioned to oppose the lens 14. When attached to the elongate base 40, the cover 72 of the power supply assembly 70 encloses a part of the surface 60 of the elongate base 40 to form at least a part of the lower portion 16 of the housing 12. When attached to the elongate base 40 in this manner, the cross section of the housing 12 along the length of the cover 72 is generally defined by the lens 14 and by the cover 72 positioned to oppose the lens 14. The cover 72 may extend the first partial length L1 of the housing 12, such that the lower portion 16 of the housing 12 is defined by the lens 14 and by the cover 72 positioned to oppose the lens 14 along the first partial length L1 of the housing 12. Along the second partial length L2 of the housing 12 not including the cover 72, the lower portion 16 of the housing 12 is defined by the lens 14 and by the surface 60 of the elongate base 40 positioned to oppose the lens 14.

The surface 60 and the cover 72 could have the same or similar geometries, although the surface 60 and the cover 72 of the LED-based light 10 can have differing geometries. The

surface 60 may be configured as a substantially flat surface, including the opposing flanges 94 extending from the longitudinal edges of the surface 60, as well as the groove 102. When the substantially flat surface 60 is positioned to oppose the lens 14 with a substantially arcuate cross section, the housing 12 has the generally bow shaped cross section shown in FIG. 4 along the second partial length L2.

The cover 72 may have a substantially C-shaped cross section. The substantially C-shaped cross section of the cover 72 could be curvilinear, or as shown in FIG. 3, could include one or more flat surfaces, for instance, a number of adjoining flat longitudinally extending surfaces, such as the exemplary surfaces 24 and 26. The lower portion 16 of the housing 12 can be entirely defined by the substantially C-shaped cover 72 along the first partial length L1 of the housing 12, or the flanges 94 of the elongate base 40 can also form a contiguous portion of the lower portion 16 of the housing 12 along the first partial length L1 of the housing 12. When the substantially C-shaped cover 72 is positioned to oppose the lens 14 with a substantially arcuate cross section, the housing 12 has the substantially circular cross section shown in FIG. 3 along the first partial length L1.

The surface 60 and/or the cover 72 can have various geometries other than those shown in the figures and described herein. For example, the surface 60 could include arcuate or polygonal geometries. The surface 60 could also include structures for coupling with other components of the LED-based light 10, or could include structures for heat dissipation, for example. The addition of such structures could result in a surface 60 that remains substantially flat, or could result in a surface 60 that is not substantially flat. The surface 60 can extend a length of the housing 12, or, for example, could terminate at a point adjacent the cover 72. For the illustrated surface 60 extending a length of the housing 12, the exposed geometry of the surface 60 could be different from the geometry of the surface 60 enclosed by the cover 72. The cover 72 could additionally have alternative geometries. The illustrated cover 72 includes, as a non-limiting example, a larger flat surface 24 at its apex compared to the exemplary surface 26 forming a portion of the side walls of 90 of the cover 72. The flat surface 24 could alternatively be enlarged, for example, to form a cover 72 with a substantially D-shaped cross section.

While the invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not to be limited to the disclosed embodiments but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims, which scope is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures as is permitted under the law.

What is claimed is:

1. An LED-based light for replacing a fluorescent light in a light fixture, comprising:
  - an elongate base defining a first surface and an opposing second surface;
  - an LED circuit board supported on the first surface of the base, the LED circuit board including at least one LED;
  - a light transmitting lens attached to the base to enclose the LED-circuit board, the lens extending a substantial length of the base;
  - a power supply circuit board located adjacent the second surface of the base, the power supply circuit board configured to supply power to the at least one LED; and

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a cover attached to the base to enclose the power supply circuit board, the cover extending only a partial length of the base, wherein

the base, the lens and the cover comprise a housing for the LED-based light, and wherein a perimeter of the housing is defined substantially by the lens and the cover along a first longitudinal portion of the housing, and substantially by the lens and the second surface of the base along a second longitudinal portion of the housing.

2. The LED-based light of claim 1, wherein the first longitudinal portion has a first cross section and the second longitudinal portion has a second cross section, and wherein a shape of the first cross section is different from a shape of the second cross section, such that the housing includes a geometric asymmetry about a plane that is normal to a longitudinal axis of the housing and that passes through a midpoint of the housing.

3. The LED-based light of claim 1, wherein the lens is arcuate and the cover is substantially C-shaped, such that the first longitudinal portion has a substantially circular shaped cross section.

4. The LED-based light of claim 1, wherein the lens is arcuate and the second surface of the base is substantially flat, such that the second longitudinal portion has a substantially bow shaped cross section.

5. The LED-based light of claim 1, wherein the first longitudinal portion adjoins the second longitudinal portion.

6. The LED-based light of claim 1, further comprising: a connector at an end of the housing configured for connection to a light fixture.

7. The LED-based light of claim 1, further comprising: a power supply assembly, the power supply assembly including the power supply circuit board and the cover, wherein the power supply assembly is selectively removably attached to the base.

8. An LED-based light for replacing a fluorescent light in a light fixture, comprising:

an elongate base;

an LED circuit board supported on the base, the LED circuit board including at least one LED;

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a light transmitting lens attached to the base to enclose the LED-circuit board; and

a power supply assembly, the power supply assembly including power supply circuitry configured to supply power to the at least one LED, and a cover enclosing the power supply circuitry, the cover extending only a partial length of the base, wherein

the base, the lens and the cover comprise a housing for the LED-based light, and wherein a perimeter of the housing is defined substantially by the lens and the cover along a first longitudinal portion of the housing, and substantially by the lens and the base along a second longitudinal portion of the housing.

9. The LED-based light of claim 8, the power supply assembly further comprising:

a connector configured for physical and electrical connection to a light fixture, the connector in electrical communication with the power supply circuitry.

10. The LED-based light of claim 8, wherein the lens is arcuate, and the cover is substantially C-shaped, such that the first longitudinal portion has a substantially circular shaped cross section, and wherein the base is substantially flat, such that the second longitudinal portion has a substantially bow shaped cross section.

11. The LED-based light of claim 8, wherein the lens is arcuate and the cover is substantially C-shaped, such that the first longitudinal portion has a substantially circular shaped cross section.

12. The LED-based light of claim 8, wherein the lens is arcuate and the base is substantially flat, such that the second longitudinal portion has a substantially bow shaped cross section.

13. The LED-based light of claim 8, wherein the first longitudinal portion adjoins the second longitudinal portion.

14. The LED-based light of claim 8, further comprising: a connector at an end of the housing configured for connection to a light fixture.

15. The LED-based light of claim 8, wherein the power supply assembly is selectively removably attached to the base.

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